National energy efficiency

monitoring report of Barbados

Stacia Howard

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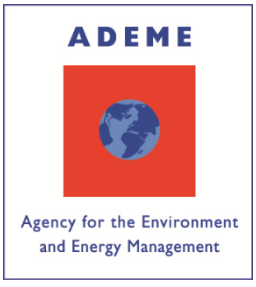
National energy efficiency monitoring report of Barbados

Stacia Howard



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Introduction

A. Objectives and content

As part of the (BIEE), the Department of Energy (DoE) of the Ministry of Energy and Water Resources of the Government of Barbados developed a database for Barbados that permits the analysis of energy efficiency indicators and the impact of policies on trends in these indicators for different sectors of the country. This data will form the baseline of the DoE's energy efficiency campaign. In addition to the data itself, this exercise is expected to strengthen the institutional capacity to collect, collate and analyse energy efficiency. This is the first time, to the author's knowledge, that energy efficiency has been assessed comprehensively in Barbados

This report analyses the information collected as part of the BIEE for the main sectors of the country, including the energy sector, households, industry, transportation, agriculture and services, and explains the energy efficiency trends in Barbados for the period 2000 to 2017.

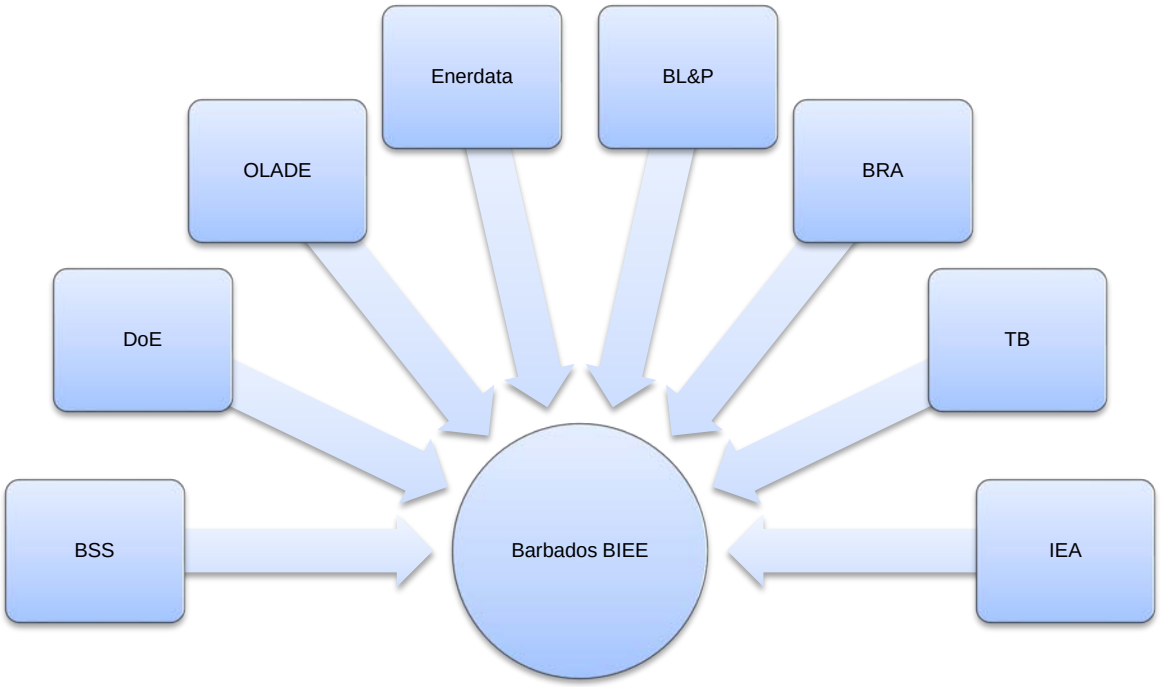
B. Data sources

The data that forms the basis for the analysis presented in this report was sourced from a number of organisations. The energy statistics data were provided by the Division of Energy (DoE) of the Ministry of Energy and Water Resources of the Government of Barbados and the Latin American Energy Organiszation (OLADE). The DoE is responsible for the collection, collation and dissemination of energy data in Barbados, and shares this information with OLADE for further dissemination through its online portal. Both of these sources were used to complete the energy statistics. The data provided in the energy balance on electricity usage by sector was supplemented by reports from the electricity utility company, the Barbados Light & Power Limited (BL&P).

The organisation officially tasked with national statistics in Barbados is the Barbados Statistical Service (BSS), which collects, collates and disseminates data on national accounts, indicators of economic activity and population and census statistics. It conducts the following surveys: Population Census, the Labour Market Survey, amongst others. The BSS was, therefore, the source of national accounts, employment and census data.

Data on the number of vehicles included in the transport sector analysis was sourced from the Barbados Revenue Authority (BRA), which, as part of its mandate to collect road taxes, also captures information on number of vehicles by type of vehicle. Information on the number of bus passengers was provided by the Transport Board (TB), which is the public bus company. The International Energy Association (IEA) was the source of data on the number of solar water heaters, total surface area installed and energy savings. Enerdata, an independent research and consulting firm specialising in global energy markets, provided information on energy consumption for cooking by type of fuel from comparable countries that informed the estimates of the electricity consumption of households for cooking.

Diagram 1
Data sources



I. Background on energy in Barbados

A. National energy management framework

1. Energy policy and legislation

In 2017, the Barbados National Energy Policy 2017 – 2037 (BNEP) was released with the vision: *"Energy security and affordabiity through diversity and collaboration: Establishing and maintaining a sustainable energy sector for Barbados".*[1] BNEP provides clear direction to the Government of Barbados in the short, medium and long term for the development of renewable and non-renewable energy as well as energy production, energy consumption and energy efficiency. The policy envisions a 75% reduction in heavy fossil fuel imports and a 75% increase in renewable energy by 2037, using natural gas as a transition fuel. Supporting the vision statement are eight visionary goals that have a number of supporting Overall Objectives, which are further detailed in Specific Sector Objectives and Measures.

Visionary Goal 1: an energy sector that offers a diversity of sustainable energy options, with a trajectory towards 100%

- Overall Objective 4: Increasing the amount of renewable energy sources used in the energy mix to the extent that it can be accommodated from a technical and socio-economic perspective
- Overall Objective 5: Increasing diversity in the types of energy sources used in both the renewable energy and fossil fuel energy sectors

[1] Barbados National Energy Policy 2017 – 2037.

Visionary Goal 2: an energy sector where consumption and production of energy resources occur with the maximum level of efficiency feasible

- Overall Objective 10: Improving the efficiency in the production and consumption of energy products within the various sib-sectors

Visionary Goal 3: an energy sector that offers basic energy products and services that are affordable to local citizens

- Overall Objective 1: Achieving stability and predictability in energy product prices over the long term
- Overall Objective 2: Achieving affordability and access to all classes of consumers in energy products and services
- Overall Objective 15: Attaining the lowest price sustainable by the local economy for various energy sources consumed in Barbados, while maintaining environmental efficiency

Visionary Goal 4: an energy sector that offers continuous and reliable supply of energy

- Overall Objective 14: Ensuring reliability and continuity of energy supply in the various local energy sub-sectors

Visionary Goal 5: an energy sector that offers opportunities for development of human capacity and collaboration

- Overall Objective 9: Increasing collaboration within the energy sub-sectors and among the cross-cutting sectors that have an impact on energy supply or consumption
- Overall Objective 11: Improving the awareness and understanding of energy production and consumption, its impacts and the associated environmental and socio-economic consequences within all sectors of the public
- Overall Objective 12: Increasing the number of persons locally with qualifications and skills relating to energy production and management of renewable and fossil fuel sources

Visionary Goal 6: an energy sector that offers significant opportunities for local entrepreneurship and international investment

- Overall Objective 6: Increasing the extent of energy resources used in Barbados that are obtained from indigenous sources
- Overall Objective 7: Encouraging local investment in energy projects and programmes in Barbados, with a view to increasing the number of shareholders and players in the various energy subsectors
- Overall Objective 8: Promoting more local entrepreneurship activities in renewable energy and increasing fossil fuel energy development throughout the energy sub-sectors
- Overall Objective 16: Establishing effective partnerships between national and international entities for local energy projects

Visionary Goal 7: an energy sector that minimises the environmental impacts and contribution to global climate change

- Overall Objective 13: Reducing the environmental impacts associated with the production and consumption of energy resources locally

Visionary Goal 8: an energy sector that is governed by sound management and clear legal regulatory frameworks

- Overall Objective 3: Establishing a consistent and comprehensive regulatory framework to govern activities in various energy sub-sectors

In addition to BNEP, Barbados has a Draft National Sustainable Energy Policy, which focuses on the sustainable production and use of various energy resources.

The energy sector is regulated by a number of acts of parliament. The oldest piece of legislation is the Utilities Regulations Act Cap 282, which governs the operations of the electric utility. This was replaced by the Electric Light & Power Act in 2013 to allow for greater competition in the electricity industry. In 2007, the Offshore Petroleum Act and the Offshore Petroleum Taxation Act were passed, containing the rules that govern the exploration and production of offshore oil in Barbados.

The Renewable Energy Rider (RER) was proposed by the electricity utility company – Barbados Light & Power Limited – and approved by the Fair Trading Commission in 2010 to allow domestic customers to sell renewable energy back to the utility company at a rate of 1.6 times the level of the Fuel Clause Adjustment. The Fuel Clause Adjustment allows the electricity utility to recover the cost of fuel used in the production of electricity, and is therefore heavily influenced by the price of fuel. In July 2016, the RER credit was changed and is now calculated using a resource cost approach, rather than being tied to the Fuel Clause Adjusment.

2. Energy management

The responsibility for national energy management lies with the Energy Division, which was established in 1978, in the Ministry of Trade, on the advice of technical assistance experts from the Overseas Development Administration of the United Kingdom. It is responsible for oil and gas, alternative energy and energy conservation (having amalgamated with the Energy Conservation Unit). The Division also provides geological and earth science services to other Government departments as well as to the private sector. The Division's objective is to ensure an efficient and reliable energy sector and includes:

- monitoring petroleum price movements;
- liaising with the CARICOM Secretariat and OLADE on regional energy issues; and,
- preparing Cabinet Papers, briefs, speeches, position papers and comments on energy, geological and earth science-related matters.

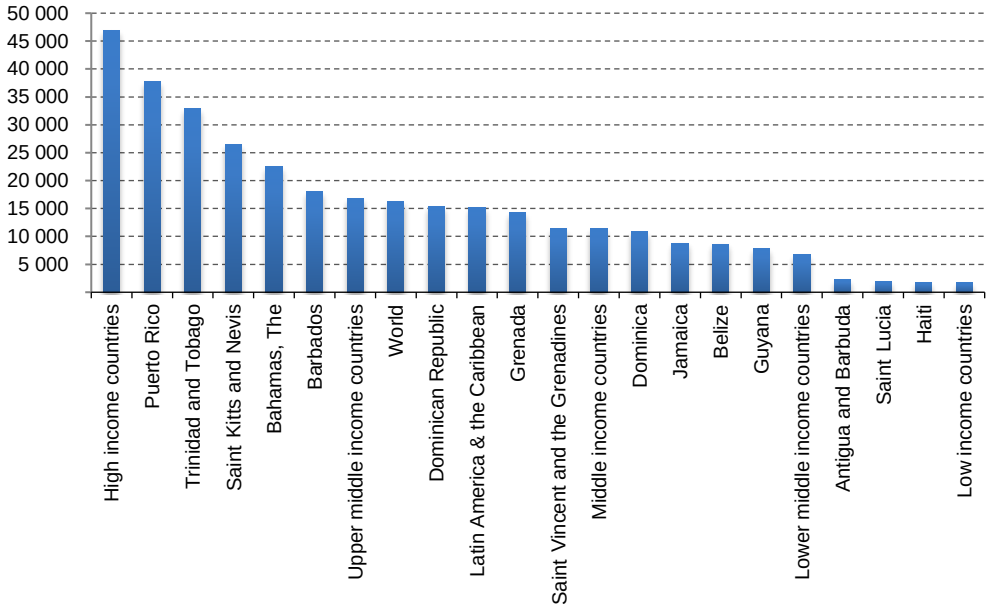
The Energy Division is comprised of an Administrative Unit, the Legal & Regulatory Unit, the Natural Resources Department, the Renewable Energy & Energy Conservation Unit and the Research & Planning Unit. The Division is also responsible for monitoring the operations of the Barbados National Oil Company Ltd. (the agency responsible for exploration, production and procurement of oil and gas), the Barbados National Terminal Company Ltd. (which is responsible for the terminalling and storage of oil products and crude oil), and the National Petroleum Corporation (which distributes the gas produced by the Barbados National Oil Company Ltd.).

B. Overall context

1. The economy

Barbados is a small island developing economy that has been pursuing strategies aimed at enhancing energy efficiency and stimulating the use of renewable energy. In 2016, GDP per capita (at a purchasing power parity basis) was estimated at $18,064, placing the country fifth amongst other Caribbean nations, but significantly less than the $46,685 average reported for high-income countries. The hotel and restaurant industry – mainly due to long-stay visitors from the United States, United Kingdom and Canada – as well as an international business and financial services industry largely drive the country's economic growth.

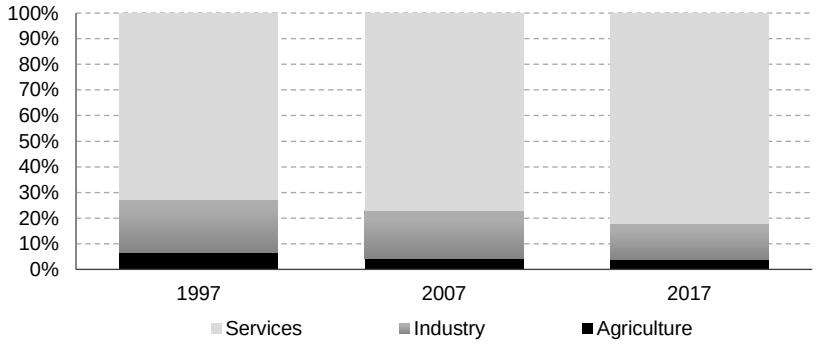
Figure 1
Comparative GDP per capita, PPP, 2016
(Current international dollar)



Source: World Bank Development Indicators.

Always a services-dominated economy, the relative importance of the services sector vis-à-vis industry and agriculture has grown in the last two decades. Services in 2017 accounted for 82.3% of GDP compared to 72.9% in 1997, while the agriculture industry only represented 3.9% and industry 13.8% in 2017.

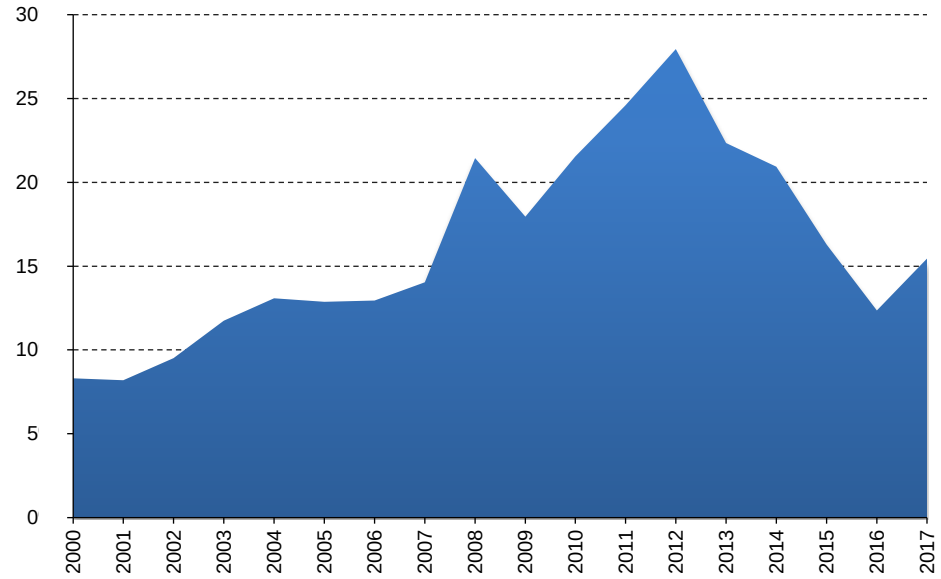
Figure 2
Breakdown of GDP
(Share of GDP)



Source: ECLAC and BIEE.

The Barbados dollar is pegged to the U.S. dollar at a rate of USD$1:BBD$2, and the fixed exchange rate is supported by the country's net international reserves. The international benchmark for the net international reserves requires fixed exchange rate countries to maintain sufficient reserves to pay for 12 weeks of imports of goods and services. There are two main means of achieving the benchmark: (1) earning enough foreign exchange through the export of goods and services and inflows on the external financial account, or (2) reducing the import bill. Barbados spends US$2 billion on imports of goods and services on average every year. Approximately 15 percent was spent on fuel, most of which is used for electricity generation (48%) and transportation (31%).[2]

Figure 3
Fuel Imports 2000 - 2017
(Percentage of imports of goods and services in Barbados)



Source: Central Bank of Barbados.

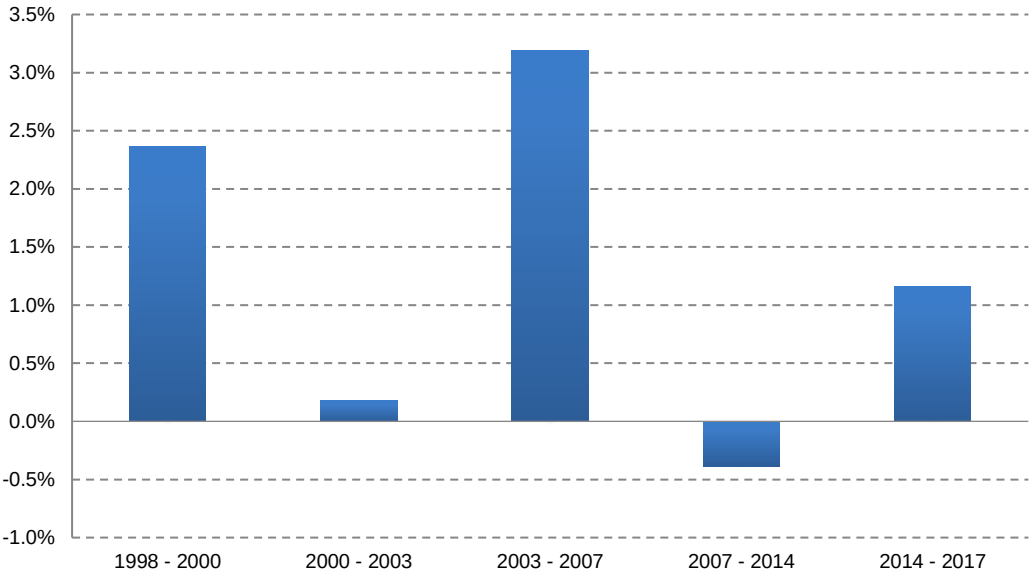
In an effort to reduce its dependence on fossil fuels – and by extension reduce the import fuel bill – and as part of its commitment to improve energy security and stability, Barbados has been promoting sustainable energy practices to shift the energy supply towards renewable energy and increasing energy efficiency and energy conservation. The Government of Barbados has set itself the goal to have converted 75% of its energy supply to renewable sources by 2037 and to have reduced the consumption of electricity by 22% by 2029.

In the aftermath of the global financial crisis in 2007, Barbados entered into its most depressed period of economic growth on record. In the seven years between 2007 and 2014, Barbados averaged annual growth of -0.4%. Even though the country has since recorded positive growth – 1.2% on average between 2014 and 2017 – economic conditions remain weak, with extraordinarily high levels of debt (137.0%), net international reserves well below the international 3-month benchmark (2 months of imports) and high fiscal deficits (5.5% of GDP)[3]. Despite these challenges, Barbados continues to make strides towards achieving its energy efficiency and renewable energy targets.

[2] United Nations Development Programme (2012). Rapid Assessment Gap Analysis, Barbados.

[3] International Monetary Fund (2018, May) 2017 "Article IV Consultation Staff Report".

Figure 4
Growth in Barbados GDP at constant prices
(Compounded annual growth rate)



Source: ECLAC and BIEE.

2. Demographic trends

The population of Barbados in 2010 was 277,821, which represented an increase of 3.4% from 2000. In addition to a slightly increasing fertility rate (1.8 in 2016 compared to 1.7 in 2000), the population continued to grow due to two main factors:

(i) An ageing population – the proportion of the population over the age of 50 increased from 24.9% in 2000 to 31.0% in 2010; and,

(ii) An increase in the non-resident population – the proportion of the population the immigrated to Barbados rose from 9.0% in 2000 to 14.5% in 2010.

Of note, the population density of Barbados is quite high at 662.8 persons/km^2 compared to an average for the Caribbean of 17.9 persons/km^2 and for the entire Latin America and Caribbean region of 31.8 persons/km$^{2.}$ According to 2016 World Bank estimates, Barbados was the 14th most densely populated country in the world and the second most densely populated country in the Caribbean after Sint Maarten.

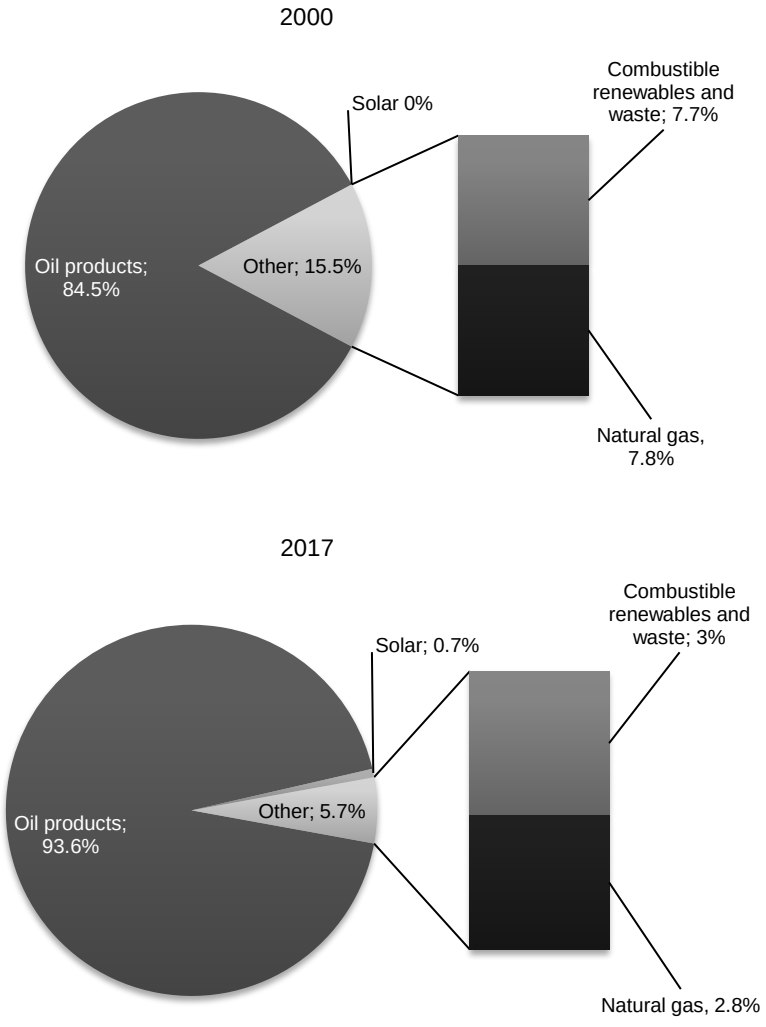
3. Geography of Barbados

Barbados is small – 431km^2 – and located in the Caribbean. The climate is tropical and oceanic, with an average temperature of 26.8°C. There are no major changes in either seasonal or daily temperatures, though there are two distinct weather seasons – wet and dry. The wet season typically lasts from June to November, which is also the same as the Atlantic hurricane season. The Green Economy Scoping Study for Barbados, produced by the United Nations Environmental Programme in 2014, noted that average air temperatures might have increased by 0.5 to 1.0°C over the last forty years.

C. Composition of energy supply

The fuel mix is dominated by oil products, and, despite efforts to incorporate alternative energy, the contribution of non-oil products actually declined between 2000 and 2017 (see figure 5). The main reason for the reduction in the share of other sources of energy is the reduction in the use of combustible renewables and waste and natural gas. Combustible renewables and waste consisted of by-products of the sugarcane industry, and has been declining in line with the reduction in the output of the industry. The use of natural gas also declined notably, and reflects the falling production levels. The introduction of a photo-voltaic farm in 2016 by the electricity company has started to have an impact on national energy supply, and is expected to continue to grow.

Figure 5
Fuel mix, 2000 and 2017
(Percentage of total energy supply in Barbados)



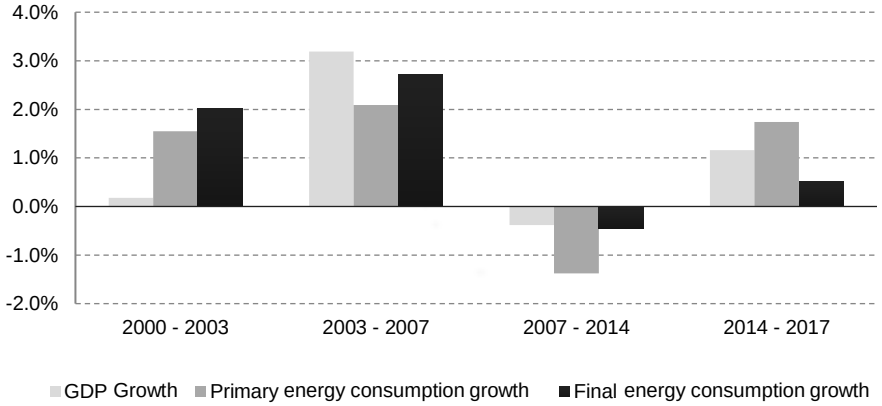
Source: ECLAC and BIEE.

II. Energy consumption

A. Primary and final energy consumption

Between 2000 and 2017, primary energy consumption in Barbados ranged between 380 ktoe and 520 ktoe per year. Growth in primary energy consumption in Barbados typically is correlated to growth in GDP. During the period when the economy experienced either negative or flat growth (2007 – 2014), GDP declined by 0.4% and primary energy consumption fell by 1.4%. Between 2014 and 2017, however, the average growth in primary energy consumption surpassed that of GDP for the first time in a decade (see Figure 6). Although final energy consumption also grew in the 2014 – 2017 period, the growth rate was notably slower than that of GDP and primary energy consumption.

Figure 6
Growth in primary energy consumption, final energy consumption and GDP
(Compounded annual growth rate)

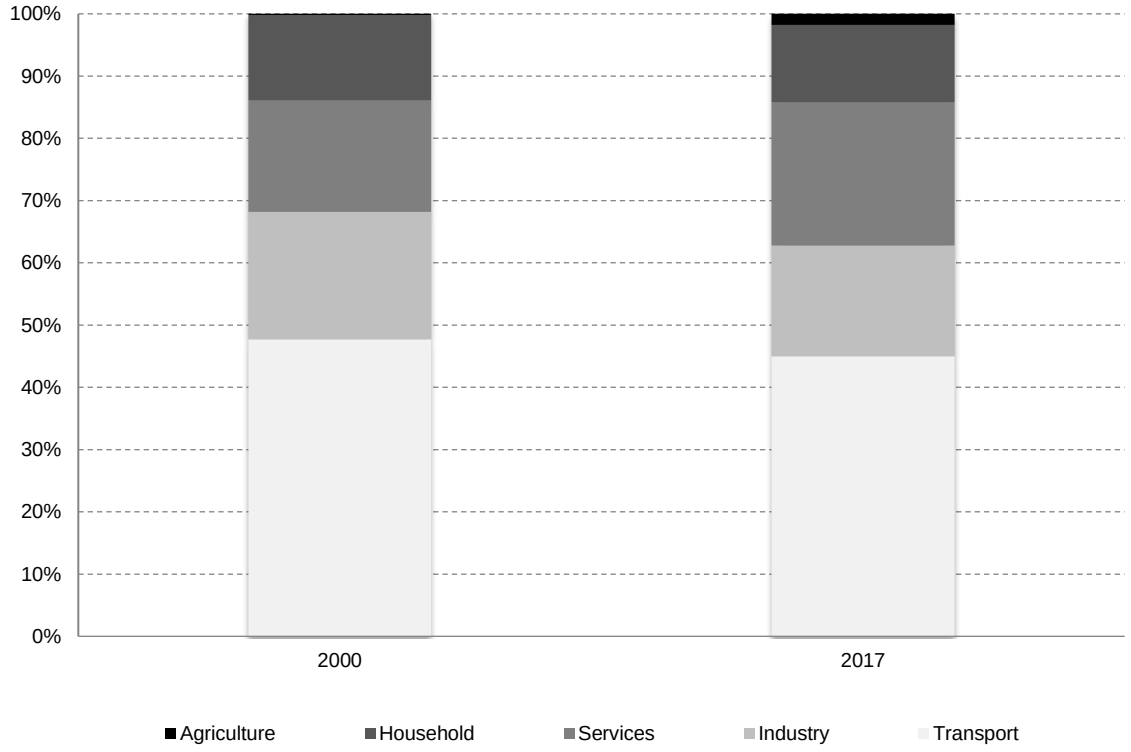


Source: ECLAC and BIEE.

B. Final energy consumption by sector

Almost half of final energy consumption is due to the transport sector, and this proportion has remained relatively stable between 2000 and 2017 (see Figure 7). The second largest consumer of energy was industry in 2000 (accounting for 20.5% of total final energy consumed), but was replaced by the services sector by 2017. Services now account for 23.0% of final energy consumed. The shifts in the shares of the services and industry sectors in final energy consumption reflect changes in the composition of economic activity.

Figure 7
Final energy consumption by sector
(Share of final energy consumption)



Source: ECLAC and BIEE.

III. Energy efficiency

A. Trends in primary and final energy intensities

Improving energy efficiency refers to situations when a given output is produced with lower inputs of energy – or, alternatively, when for a given input of energy, there are increased outputs. Energy efficiency can be improved by:

- shifting the energy mix to modes that produce greater levels of output for lower levels of input;
- reducing wasted energy; or,
- shifting the outputs to those that require lower levels of energy.

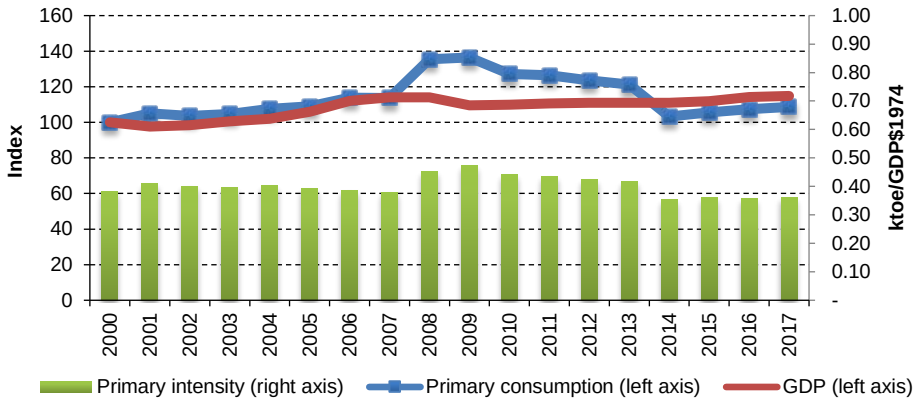
Typically, energy efficiency policies attempt to address all three of these areas through incorporating renewable energy in the energy mix (as these typically are 100% efficient), encouraging energy savings wherever possible and producing goods and services that require lower inputs of energy.

Energy intensity captures the amount of energy required to produce one unit of output, and is calculated as the ratio of energy consumed to output. Declines in energy intensity ratios, therefore, imply that energy efficiency is improving. At the national level, primary energy intensity is the ratio of primary energy consumption to total GDP, and final energy intensity is the ratio of final energy consumption to total GDP. The primary energy intensity in Barbados was 0.36 at the end of 2017, while the final energy intensity was 0.25.

By the end of 2017, primary energy intensity was 5.4% lower than the level recorded in 2000. These results, however, mask very different performances by period. Between 2000 and 2009, primary consumption and GDP growth generally kept apace, resulting in only marginal changes in energy intensity. In 2008 GDP growth stagnated and in 2009 the country entered into a recession. At the same time, however, energy consumption grew by one of the fastest rates during the 2000 to 2017 period. These diverging trends led to an increase in primary energy intensity. From 2010 to 2014, primary energy consumption declined at an average rate of 5.4% while GDP averaged positive growth of 0.2%,

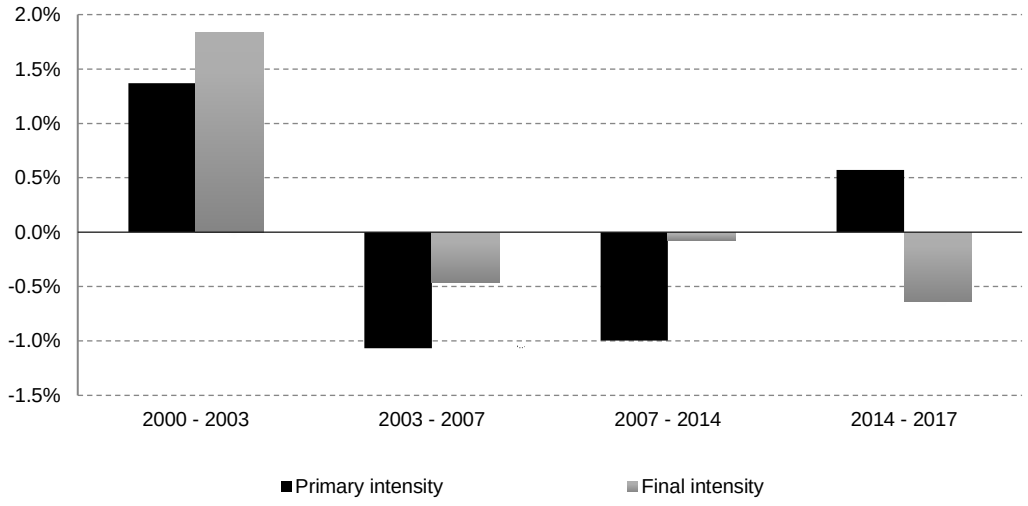
thus returning the country to a situation with decreasing levels of energy intensity. The 2014–2017 period shows a stabilisation in this trend, with energy intensity 5.4% lower than in 2004. Although final energy intensity generally exhibited a similar trend to that of primary energy intensity, the 2014–2017 period shows a divergence, with final intensity continuing to improve and primary energy intensity deteriorating somewhat (see figure 9). This outcome is the result of slower growth in final energy consumption relative to GDP growth as well as primary energy consumption, and generally reflects the continuation of the country's gradual shift away from industry and agriculture.

Figure 8
Trends in primary energy intensity, primary energy consumption and GDP
(Index and KTOE/GDP)



Source: ECLAC and BIEE.

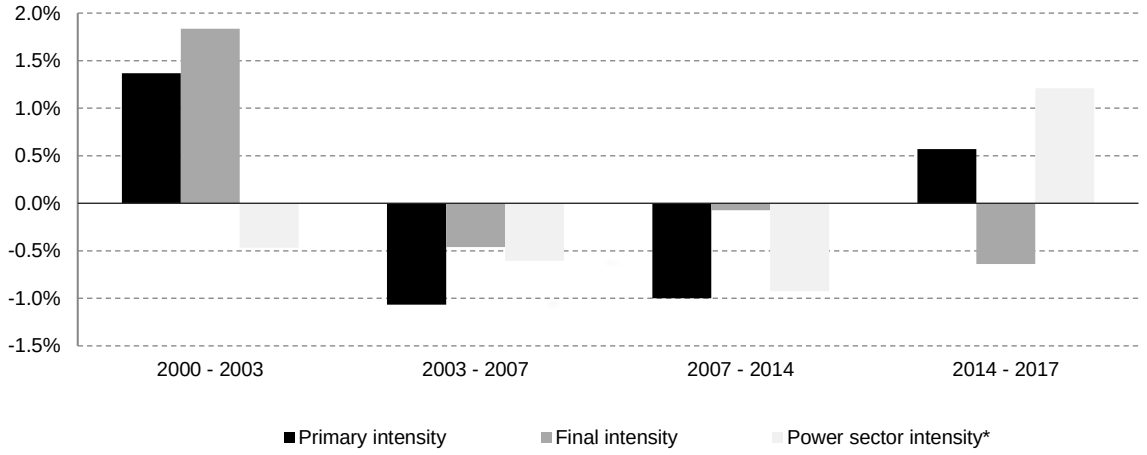
Figure 9
Growth in primary and final energy intensities
(Compounded annual growth rate)



Source: ECLAC and BIEE.

The difference between primary intensity and final intensity represents the intensity of the power sector. Until the 2014–2017 period, power sector intensity had been declining. The divergence in the trends of primary intensity and final intensity, however, reflected an increase in power sector intensity to the tune of an annual average of 1.2%.

Figure 10
Power sector intensity
(Compounded annual growth rate)

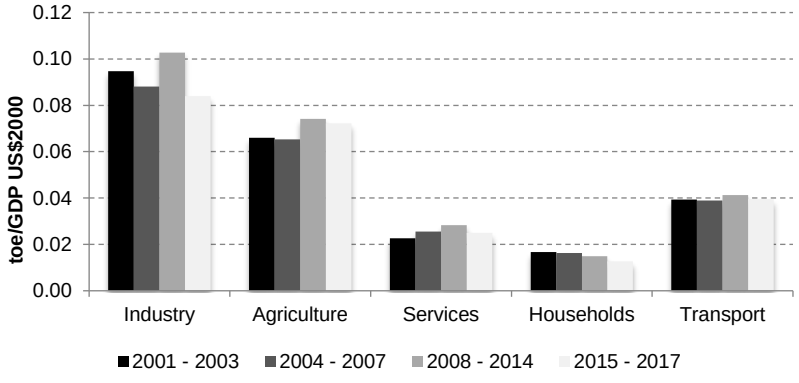


*Power sector intensity represents the ratio between 'net consumption of the power sector' (i.e.input of power plants minus electricity production) and GDP
Source: ECLAC and BIEE.

B. Trends in energy intensity by sector

Industry is the most energy intensive sector in Barbados, followed by agriculture and transport. Apart from the increase in the 2008–2014 economic slump, final energy intensity of industry has been declining at the fastest rate amongst all five sectors. In fact, final energy intensity of agriculture and services only declined in the 2015–2017 period and final intensity of transport has generally remained flat. The sector that experienced the most positive outcome was the household sector, where final energy intensity has declined throughout all four periods (see figure 11).

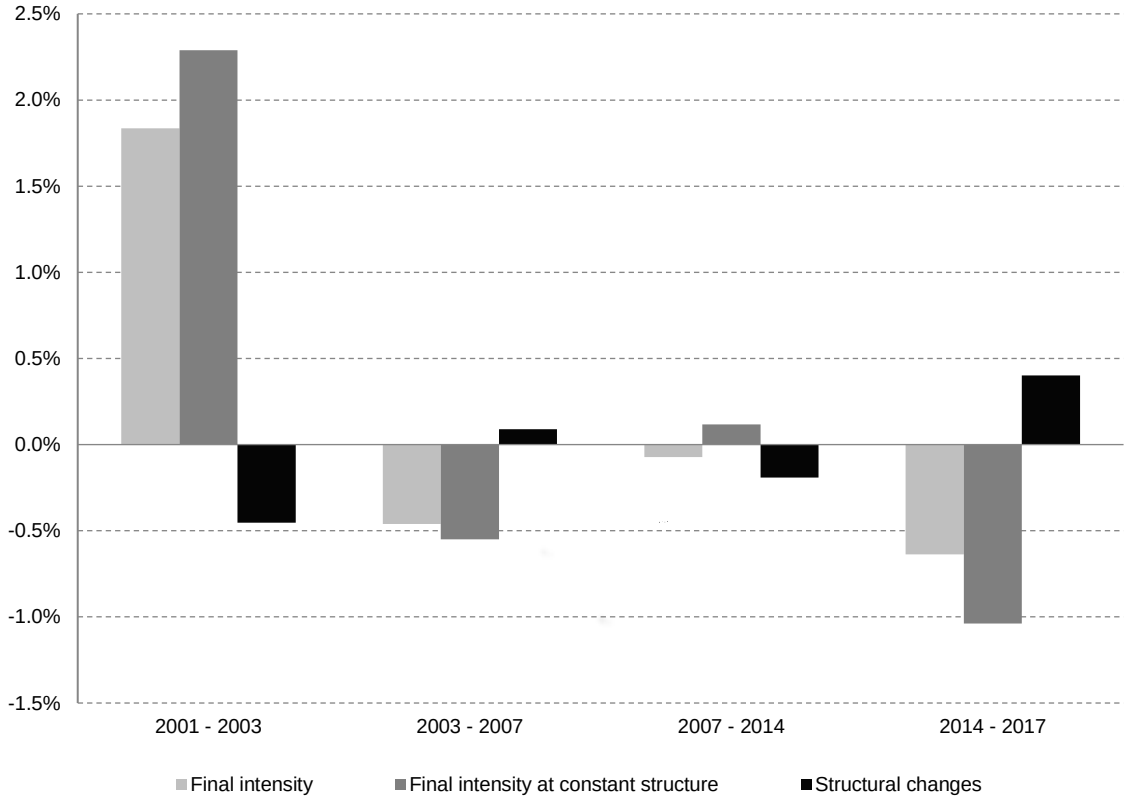
Figure 11
Trends in final energy intensity by sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.

Structural changes have not had a major impact on final energy intensity: less than 1% of the final energy intensity trends can be explained by changes in the structure of GDP (see figure 12). Although the share of the services sector grew by 10 percentage points, this outcome is not surprising given that the services sector already accounted for almost ¾ of GDP at the start of the period.

Figure 12
Impact of structural changes in final energy intensity
(Compounded annual growth rate)

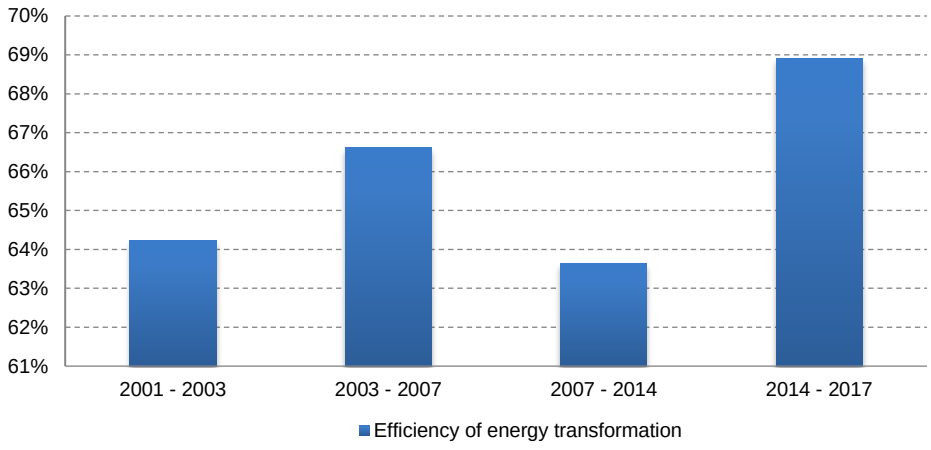


Source: ECLAC and BIEE.

IV. Energy efficiency trends in energy sector

The energy sector of Barbados is fairly simple. There is one electricity utility company and the country is not a net exporter of energy. Most of the energy is imported – with the exception of by-products of the sugar cane industry, solar power and some natural gas – and goes either into transformation into electricity or directly to the industry or transportation sectors. The efficiency of energy transformation – as estimated by the ratio of final energy consumption fo primary energy consumption – had been improving steadily, and the ground lost during the recession appears to have been recouped in the 2014 – 2017 period (see figure 13).

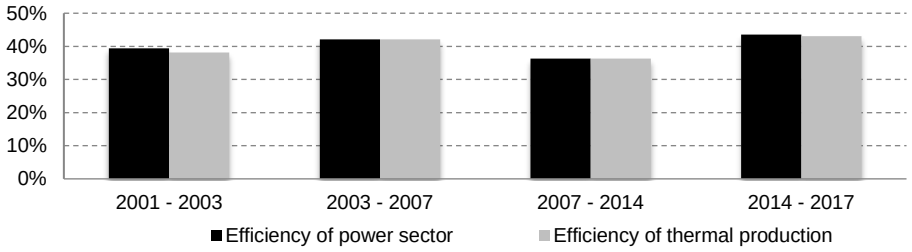
Figure 13
Efficiency of energy transformation
(Ratio of final energy consumption to primary energy consumption)



Source: ECLAC and BIEE.

The share of renewables in power generation is very small, so there is no meaningful difference between the average efficiency of power generation and that of thermal generation. Efficiency in this case is measured as the ratio of electricity produced to energy consumed in transformation. The ratio of the entire power sector would include renewable energy and fossil fuels, while that of thermal production would only nclude fossil fuels. The difference in the ratios in the last period reflects the inclusion of solar power in the energy inputs in 2014 (see figure 14). Solar power consumption grew from 0.5 ktoe in 2014 to 2.2 ktoe in 2017, an average annual increase of 67.6%, due to the coming on stream of the electricity utility's new photo-voltaic farm. The installation is expected to contribute 10MW of electricity to the national grid at full capacity.

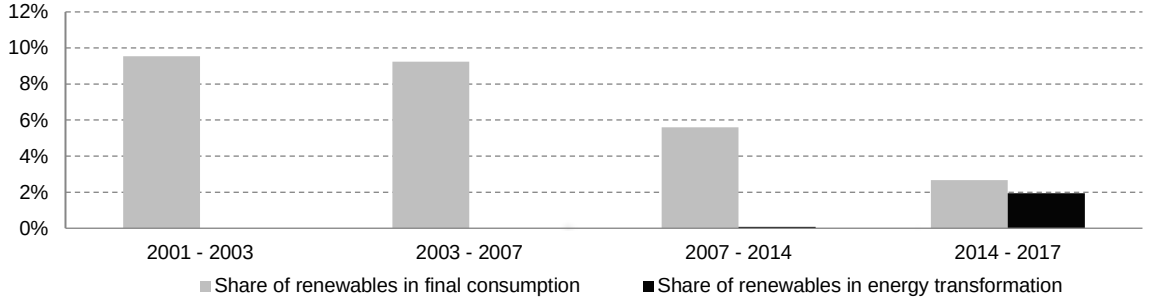
Figure 14
Impact of renewables on power generation efficiency
(Ratio of electricity produced to energy consumed in transformation)



Source: ECLAC and BIEE.

The introduction of solar energy is not the country's first forray into using renewable sources of energy. The industrial sector uses by-products from the sugar cane industry in final energy consumption, though its share of final energy consumption has been declining with the closure of one of the main factories that consumed this energy source. As shown in figure 15, by-products of the sugar cane industry represented only 3% of final energy consumption at the end of 2017, compared to 10% in 2000. The electricity utility company has been investigating ways to use a different species of sugar cane to develop electricity, and, if successful, would provide another renewable energy source for energy transformation. Finally, the electricity utility also plans to build a wind farm to permit the production of electricity from wind, and work on this project is in preliminary stages.

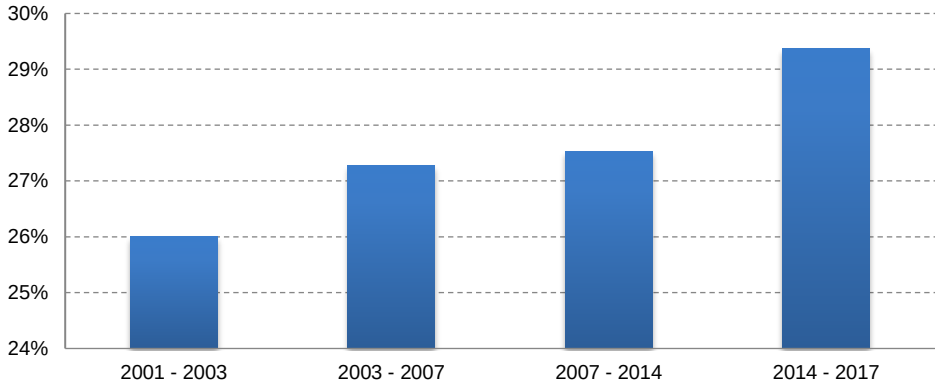
Figure 15
Use of renewable energy in energy sector
(Percentage)



Source: ECLAC and BIEE.

The electricity utility company's focus on renewable energy comes at a time when the share of electricity in final consumption has been steadily increasing. In the 2001 – 2003 period, electricity represented 26.3%, and had grown to 29.1% by the 2015 – 2017 period (see figure 16). The increasing use of electricity reflects the increased use of electricity by households, industrial companies and the agricultural sector.

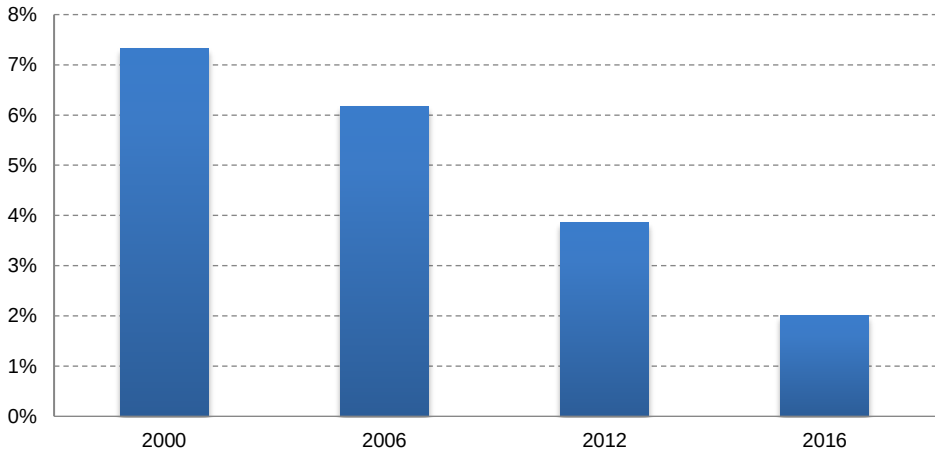
Figure 16
Share of electricity in final consumption
(Percentage of total final energy consumption)



Source: ECLAC and BIEE.

Power transmission and distribution losses have been improving, dropping from 5.0% of net electricity production in 2000 to just 1.6% at the end of 2017 (see figure 17).

Figure 17
Power and distribution losses
(Percentage of net electricity production[a])



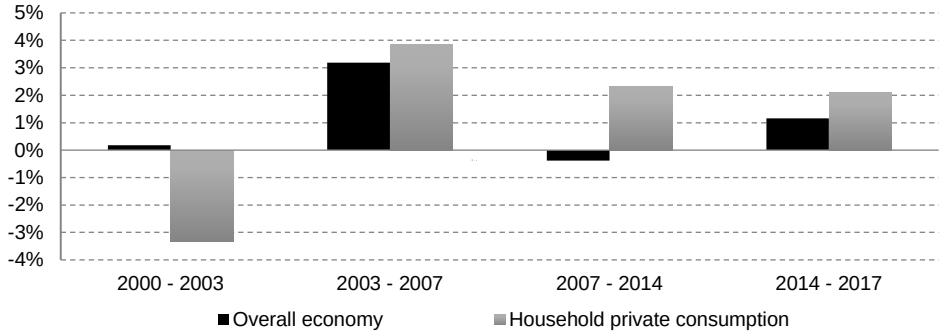
Source: ECLAC and BIEE.
[a] Net electricity production = electricity production + imports of electricity – exports of electricity – electricity from auto-producers.

V. Energy efficiency trends in households sector

A. Trends in household energy consumption

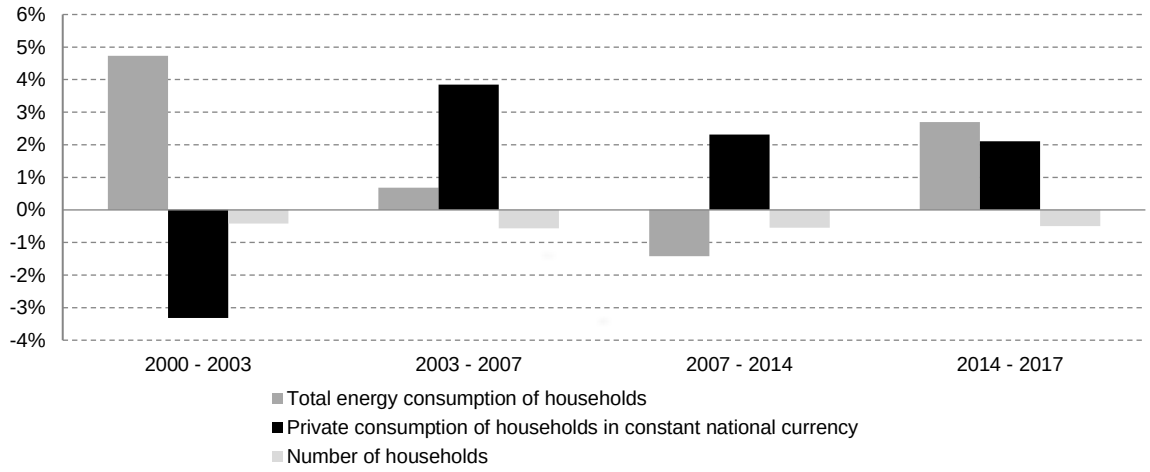
Household private consumption continued to grow throughout the economic slump between 2007 and 2014, unlike the last period of weak economic growth in 2000 – 2003 when it fell by an annual average of 3.3% (see figure 18). Also unlike the last economic slump, total energy consumption of households declined in the 2007 – 2014 period compared to an average annual increase of 4.7% during the 2000 – 2003 period (see figure 19).

Figure 18
Growth in economic activity and private household consumption
(Compounded annual growth rate)



Source: ECLAC and BIEE.

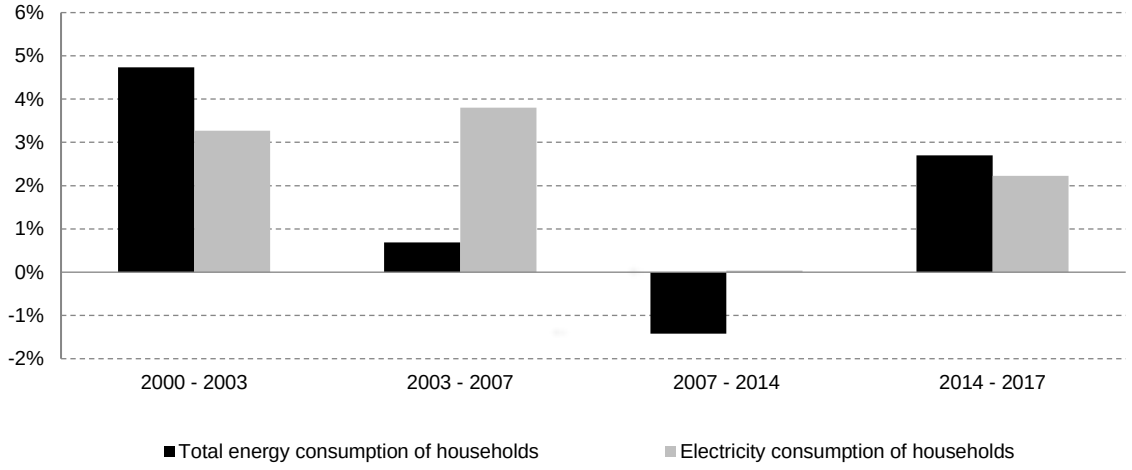
Figure 19
Trends in household energy consumption, private consumption and number of households
(Compounded annual growth rate)



Source: ECLAC and BIEE.

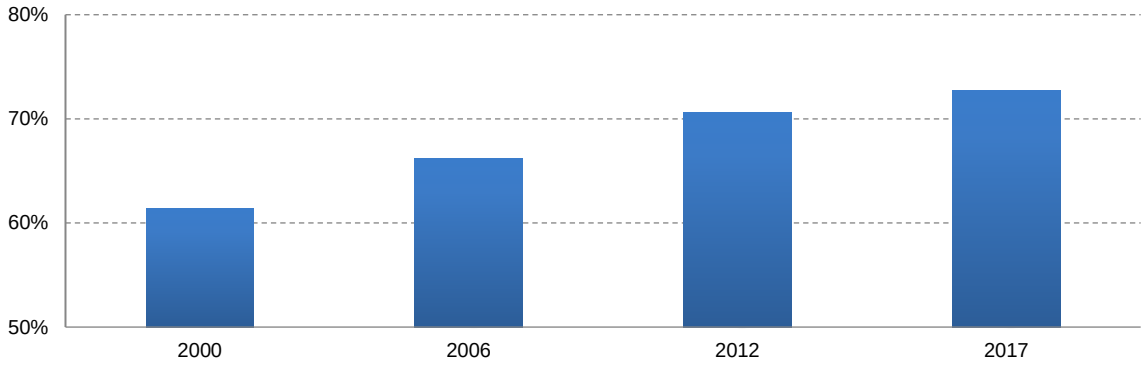
The slowdown and eventual decline in energy consumption growth are the result of a reduction in the number of households coupled with increased penetration of appliances, while the decline in total energy consumption growth in the latter two periods, in particular, reflect the decreasing use of LPG. As households have decreased their use of LPG and increased their use of appliances, electricity consumption of households has been increasing, as reflected in positive growth rates for electricity consumption, even in periods of declining total energy consumption (see figure 20). As a result, the share of electricity in total household energy consumption increased by almost 20 percentage points between 2000 and 2017 (see figure 21).

Figure 20
Growth in total energy consumption of households and electricity consumption of households
(Compounded annual growth rate)



Source: ECLAC and BIEE.

Figure 21
Share of electricity consumption in total household energy consumption
(Percentages)

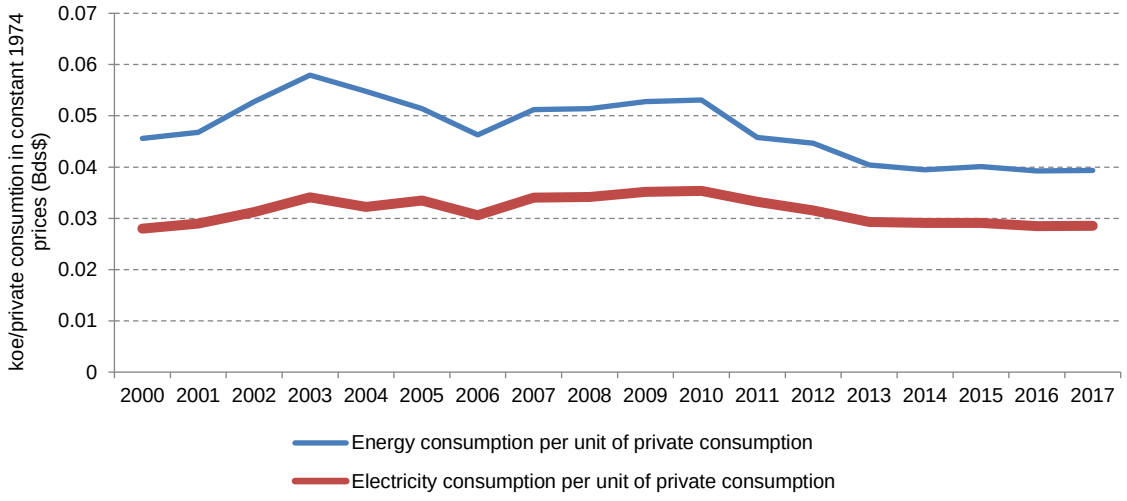


Source: ECLAC and BIEE.

B. Trends in household energy efficiency

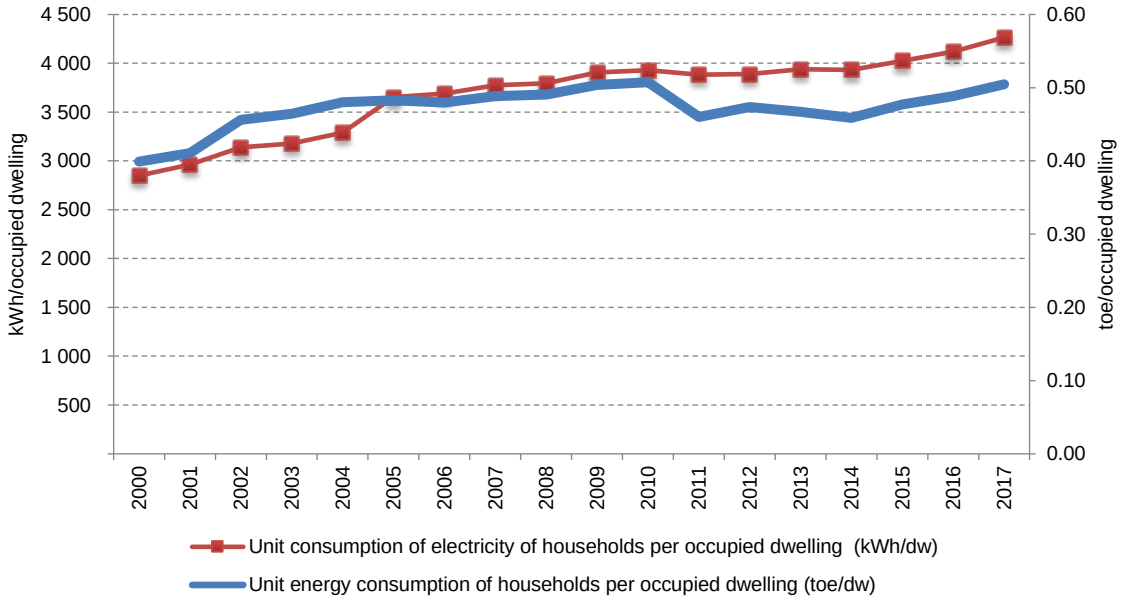
The gradual decline in household energy consumption observed in figure 19 has contributed to an improvement in household energy efficiency (see figure 22 and figure 23). Both energy consumption per unit of private consumption and electricity consumption per unit of private consumption have averaged annual declines since the 2003 – 2007 period, despite continued growth in household private consumption (see figure 24). This outcome illustrates that shifting to more energy efficiency modes has had a noticeable impact on overall energy efficiency in the household sector. In the 2003 – 2007 and 2007 – 2014 periods, electricity efficiency improved at a slower rate than overall energy efficiency, reflecting the increased use of appliances. Only in the 2014 – 2017 period did the improvement in electricity efficiency surpass that of overall energy efficiency.

Figure 22
Household energy efficiency trends
(Koe/private consumption in constant 1974 prices (Bds$))



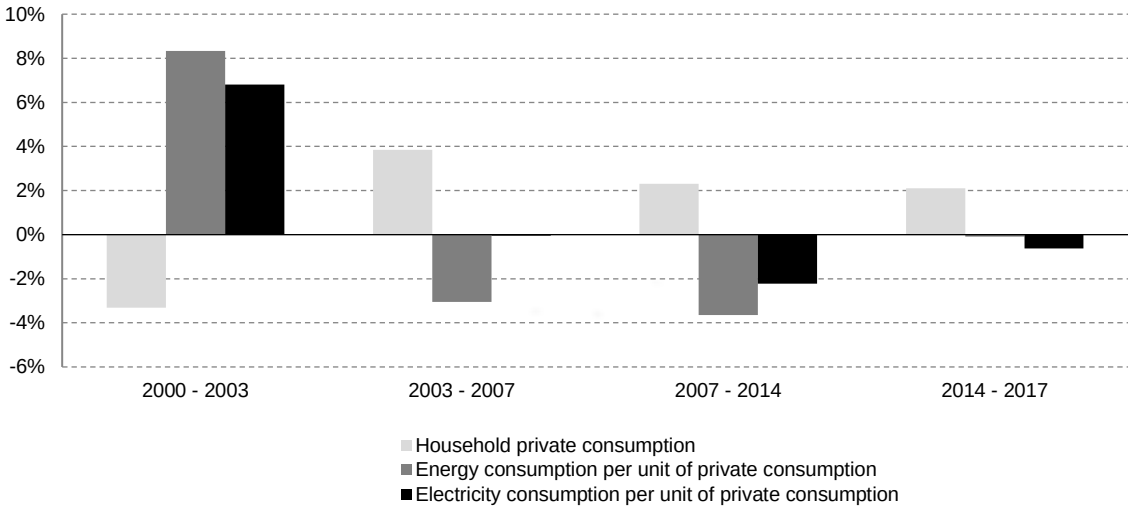
Source: ECLAC and BIEE.

Figure 23
Unit consumption of electricity and total energy per occupied dwelling
(kWh/dw and toe/dw)



Source: ECLAC and BIEE.

Figure 24
Household energy efficiency trends, summarized by period
(Compounded annual growth rate)



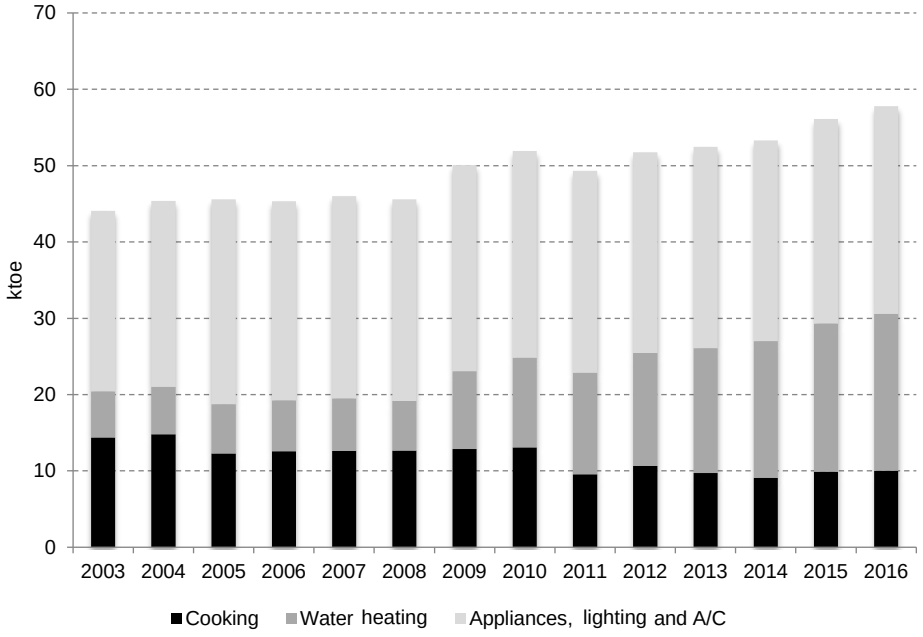
Source: ECLAC and BIEE.

C. Energy consumption and efficiency by end use

1. Energy consumption by end use

Household energy consumption is shifting away from cooking to water heating and appliances, lighting and air conditioning (see figure 25). The main drivers of this shift are the reduction in the use of LPG for cooking, the increase in the penetration of solar water heaters and the increase in appliance usage generally.

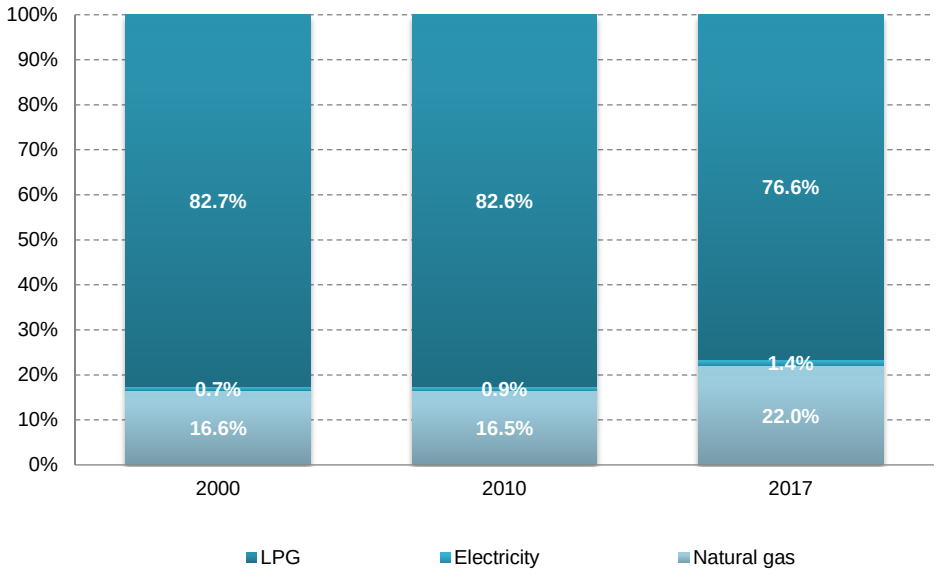
Figure 25
Trends in household energy consumption by end use[a]
(Ktoe)



Source: ECLAC and BIEE.
[a] The estimate of water heating includes the energy savings from solar water heaters, which are not included in the energy balance of Barbados, as well as an estimate of energy used in electric water heaters.

The shift away from LPG to natural gas (shown in figure 26) is the result of an increase in the number of households connected to the natural gas grid. According to data from the National Petroleum Corporation of Barbados, between 2000 and 2017, the number of active residential customers increased by 71.4%, or an annual average of 3.3%. The natural gas grid is estimated to have covered approximately 25% of the country at the end of 2017, and NPC has been mandated by the Government of Barbados to make natural gas available to the entire country. The main obstacle to achieving this goal is the low production of natural gas domestically. Importing greater quantities of natural gas is being considered through an Eastern Caribbena Gas Pipeline, which would consist of a 600-mile long network of undersea pipelines from Tobago to a number of Eastern Caribbean countries, including Barbados.

Figure 26
Composition of energy for cooking
(Percentage of total energy consumption for cooking)



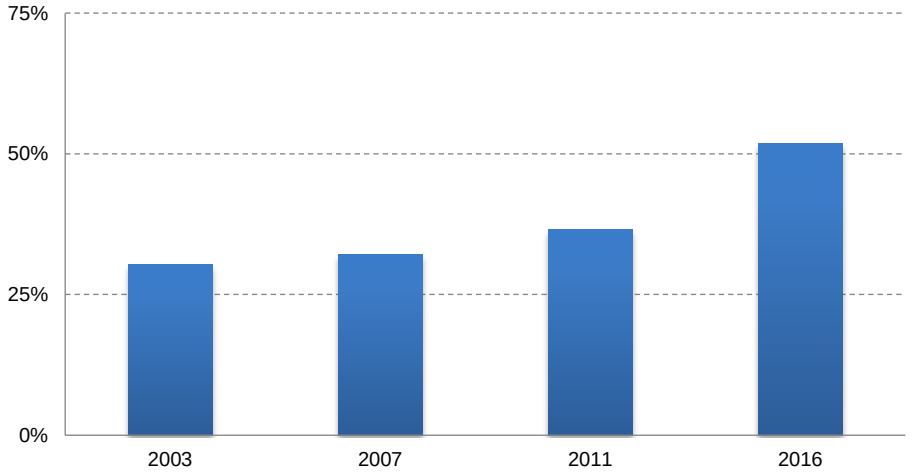
Source: ECLAC and BIEE.

Solar energy is the most popular source of water heating in Barbados, but the energy savings from solar water heaters are not currently included in the energy balance of Barbados. The estimates of energy savings from, and the number of, solar water heaters were taken from the annual Solar Heat Worldwide Reports of the IEA. According to the 2018 report (which includes data up to 2016), Barbados had the highest capacity of cumulated glazed and unglazed water collectors per inhabitant in operation at 515 kW_{th}/1,000 inhabitants, almost 100 kW_{th}/1,000 inhabitants more than the next nearest country, Austria, with 418 kW_{th}/1,000 inhabitants. Furthermore, data from these reports show that the percentage of households with solar water heaters increased by almost 20 percentage points between 2003 and 2016 (see figure 27). The energy savings from solar water heating was estimated to have risen from 5.8 ktoe in 2003 to 20.3 ktoe in 2016, an increase of 251%.

The rapid growth in solar water heating reflects two main factors. Firstly, solar water heating is a fairly mature technology in Barbados, as solar water heaters have been on the market since 1974. Secondly, and arguably most importantly, the market has been supported by a range of fiscal incentives, many of which have continued to evolve since the first incentive was introduced in 1974. In that year, solar water heater raw materials were exempted from import duties (which one report estimated lowered the installed cost of a solar water heater by between 5% and 10%[4]) and a 30% consumption tax was placed on electric water heaters. In 1980, individuals were allowed to deduct the full cost of installing a solar water heater for income tax purposes; this measure remained in place until 1992 when it was suspended as part of International Monetary Fund-supported economic structural reforms. In 1996, the income tax deduction was reinstated, modified in 2008 and remained until the 2014/15 government fiscal year. In 2017, therefore, there were no specific incentives for solar water heaters, but the industry continued to benefit from broader incentives aimed at encouraging the adoption of renewable energy and energy efficiency solutions.

[4] Perlack, B. and Hinds, W. (2003) *'Evaluation of the Barbados Solar Water Heating Experience'*

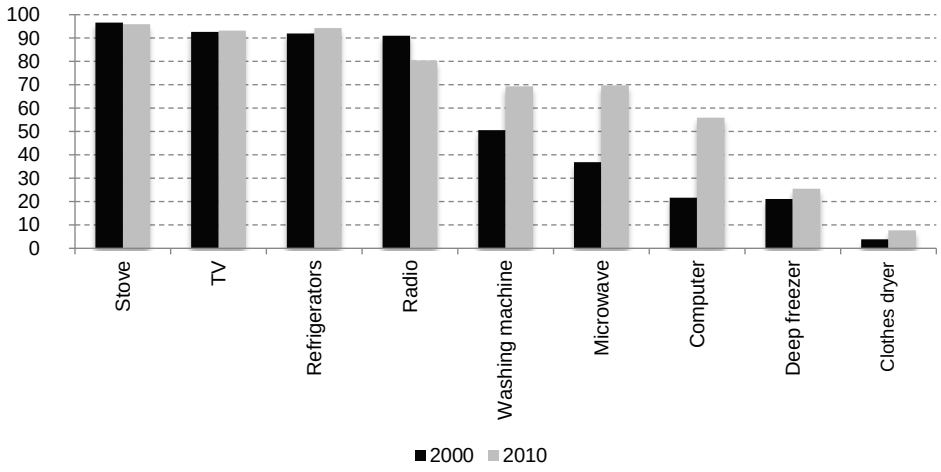
Figure 27
Penetration of solar water heaters
(Percentage of households with solar water heaters)



Source: ECLAC and BIEE.

Household ownership of appliances has also increased fairly rapidly, particularly for those appliances for which the penetration rate in 2000 was under 50% (see figure 28). The three fastest growing appliances between 2000 and 2010 were computers (from 22% to 56%), microwaves (from 37% to 70%) and washing machines (51% to 69%). The penetration rates of stoves, TVs, refrigerators and radios were already high (i.e. above 90% of households), although the percentage of households with radios declined from 91% in 2000 to 80% in 2010.

Figure 28
Penetration of appliances
(Percentage of households)

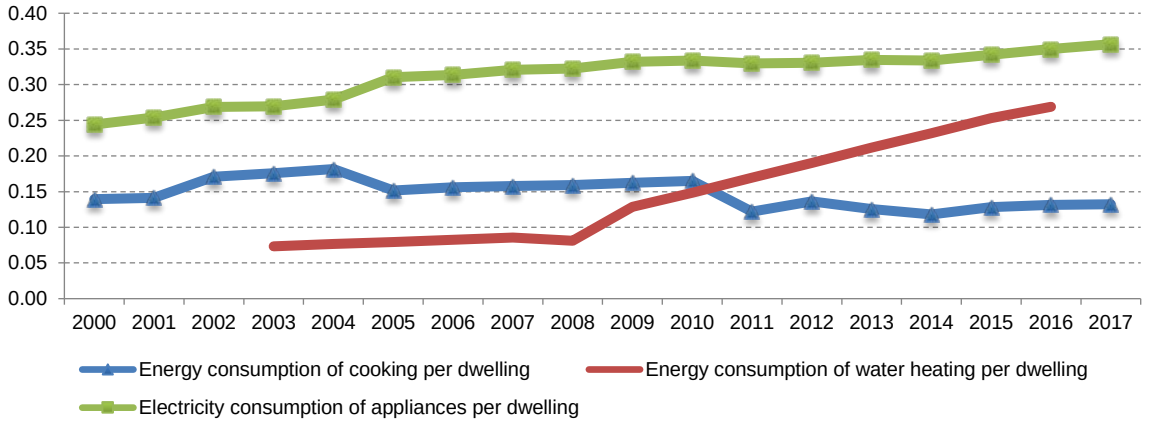


Source: ECLAC and BIEE.

2. Energy efficiency by end use

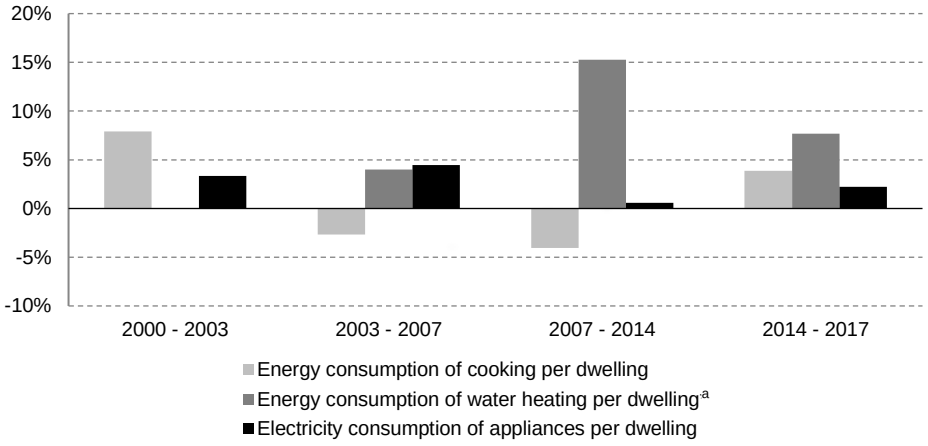
Energy efficiency by end use shows that while cooking became more efficient over the period under review – particularly after 2004 – and the savings from solar water heating grew rapidly after 2008, the increased penetration of appliances resulted in higher electricity consumption per dwelling. As depicted in figure 30, however, it is clear that even though electricity consumption per dwelling is growing, the growth rate has been slowing, possibly reflecting greater penetration of efficient appliances. It should also be noted that the increase in energy consumption for cooking in the last period might reflect the improvement in household private consumption.

Figure 29
Energy efficiency of households by end use



Source: ECLAC and BIEE.

Figure 30
Energy efficiency of households by end use, by period
(Compounded annual growth rate)



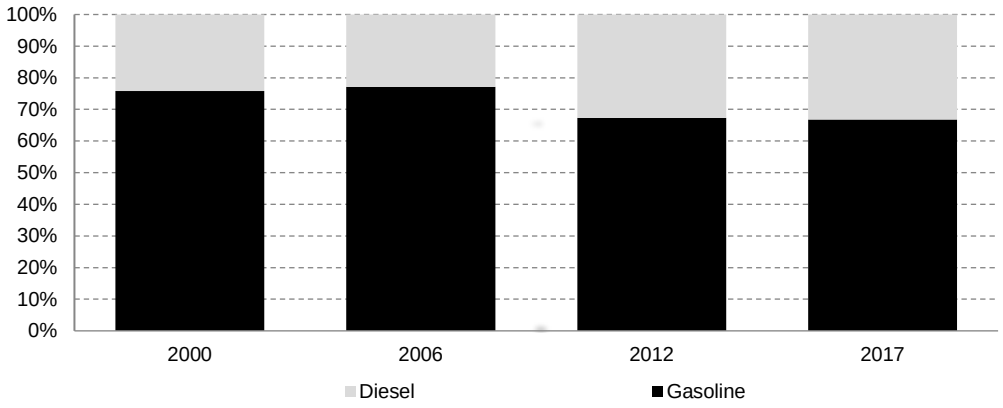
Source: ECLAC and BIEE.
[a] Energy consumption of water heating includes both solar water heaters and electrical water heaters. The solar water heaters account for 99% of total energy consumption for water heating, and essentially represent energy savings through avoided fossil fuel energy use.

VI. Energy efficiency trends in transport sector

The domestic transport sector in Barbados consists of road transport, as there is no domestic air, sea or rail transport. Road transportation primarily uses gasoline, although the use of diesel has been rising (see figure 31) and there has been an increase in the number of electric vehicles. The energy consumption of electric vehicles is not included in this analysis due to the inability of the electricity utility company to isolate energy consumption to power these vehicles from the total energy consumption of residential customers. Nonetheless, estimates from the main provider of electric vehicles – Megapower Ltd. – suggests that there might have been 300 electric vehicles in operation at the end of 2017 with an average capacity of 24kWh per vehicle.

The transport sector has a system of somewhat inconsistent incentive programmes. At present hybrid, solar, compressed natural gas and liquid petroleum gas vehicles attract an excise tax at a flat rate of 20 percent compared to as high as 120 percent on traditional vehicles. Vehicles are also subject to an import duty of 45 percent, an environmental levy of US$750 (and US$1000 for used vehicles) and excise tax of 17.5 percent. In relation to road taxes, however, the story is a bit different. Road taxes in Barbados are based upon the weight of the vehicle, where rates charged can range from US$200 to US$800. Given that electric vehicles carry large battery packs and therefore weigh more than traditional fossil fuel vehicles, they tend to attract a higher rate of road tax relative to comparable fossil fuel vehicles.

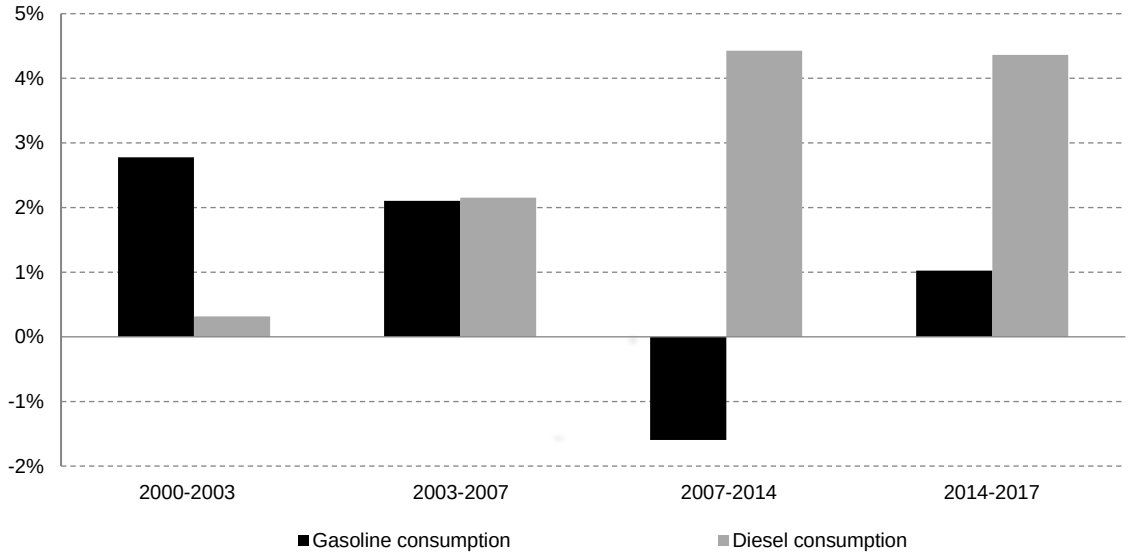
Figure 31
Fuel mix in transport sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.

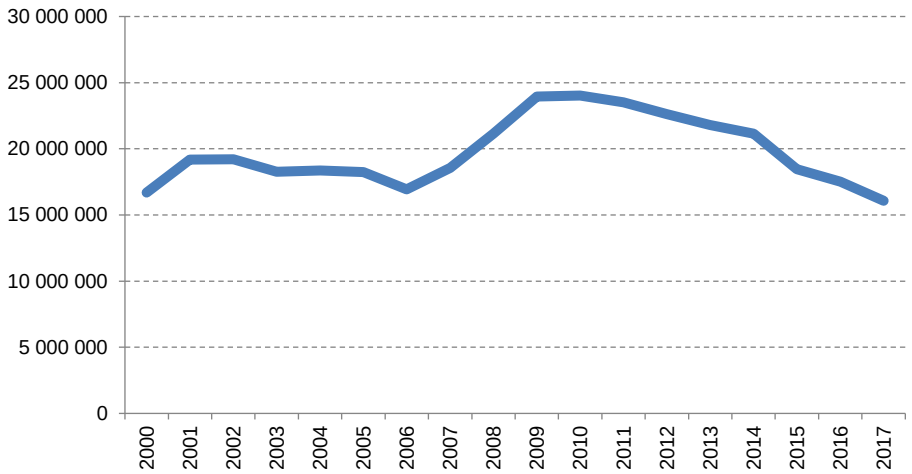
Diesel consumption has grown by 4.4% on average every year since 2007, while gasoline consumption growth has been relatively flat (see figure 32). The growth in diesel consumption has persisted despite a reduction in the bus passenger traffic in the lone public bus company, the Transport Board. Bus passenger traffic declined by an annual average of 5.6% between 2010 and 2017 due to the increasing unavailability of buses (see figure 33). The persistent increase in diesel consumption may be due to higher penetration of diesel-powered vehicles in the household sector.

Figure 32
Growth in fuel consumption by type
(Compounded annual growth rate)



Source: ECLAC and BIEE.

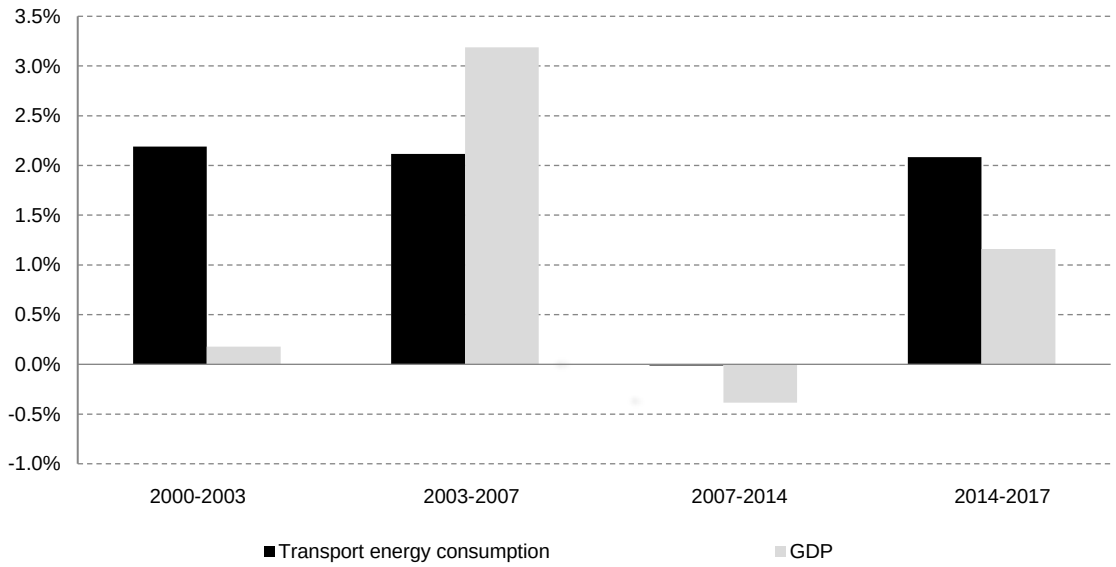
Figure 33
Passenger traffic on Transport Board buses
(Number of passenger trips)



Source: ECLAC and BIEE.

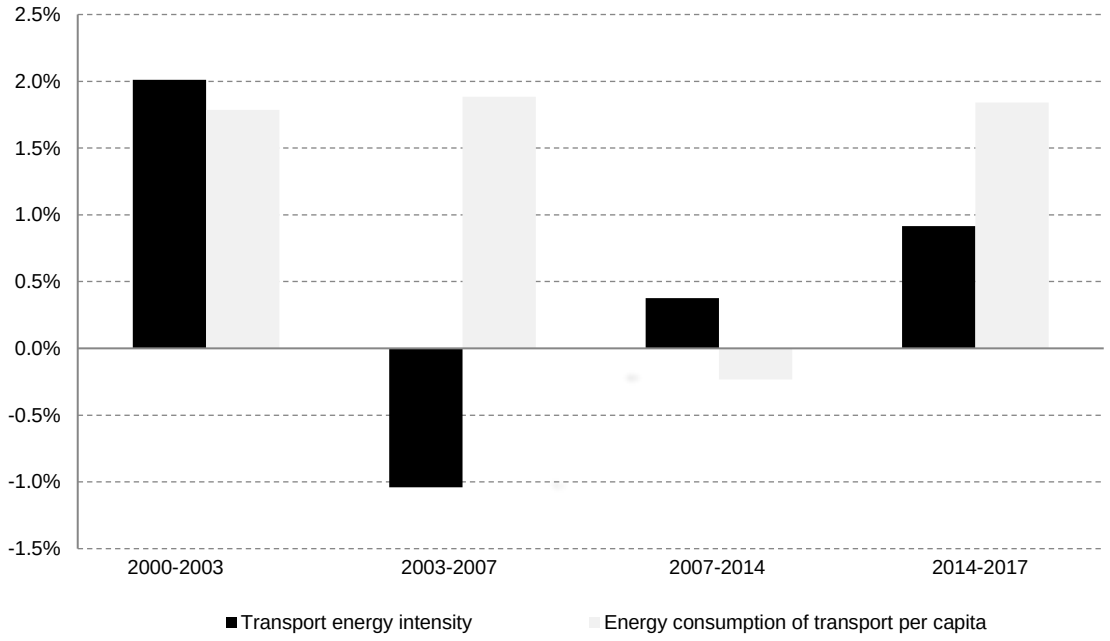
Apart from the 2007–2014 period, when the economy declined by an annual average of 0.4%, transport energy consumption has increased by just over 2% per year (see figure 34). A similar trend is observed in the energy consumption of transport per capita, which increased by just under 2% per year in all periods except the 2007–2014 period (see figure 35). Transport energy intensity, however, declined in the 2003–2007 period when GDP grew faster than transport energy consumption and has been slowly increasing since.

Figure 34
Growth in energy consumption of transport sector and GDP
(Compounded annual growth rate)



Source: ECLAC and BIEE.

Figure 35
Energy efficiency of transport sector
(Compounded annual growth rate)

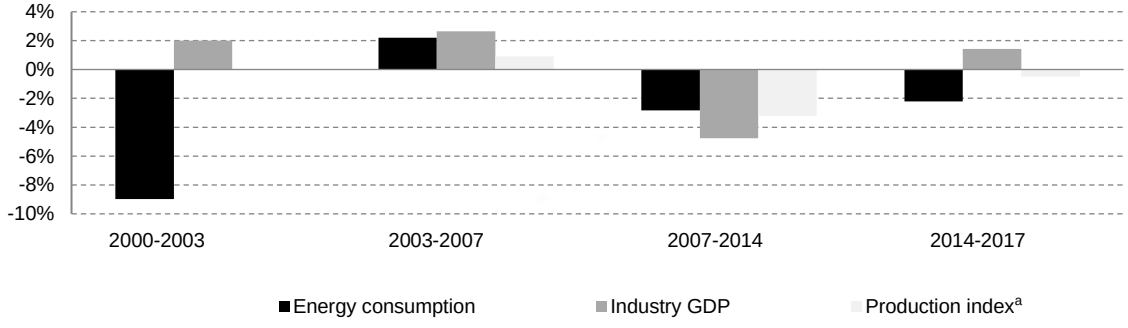


Source: ECLAC and BIEE.

VII. Energy efficiency trends in industry sector

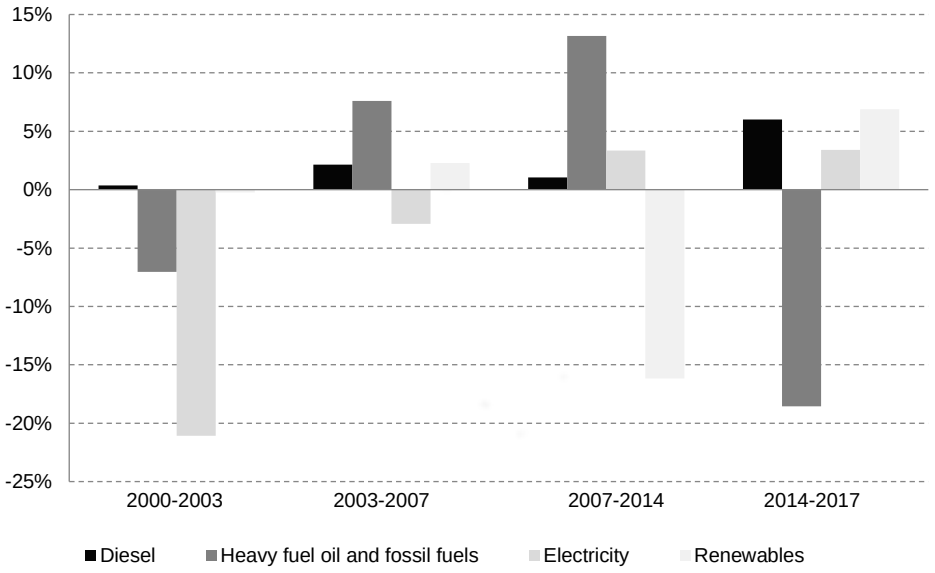
The industrial sector accounts for a small, and declining, share of GDP: 13.8% has been declining apart from the 2003 – 2007 period. Industry has been declining and this is reflected in declines in the production index in particular (see figure 36). Trends in energy consumption generally track those of industry GDP and the production index, but there was a divergence in the 2014 – 2017. Industry GDP increased by 1.4% on average and the production index declined marginally (compared to a 3.2% decrease in the previous period). Energy consumption, on the other hand, continued to decline, reflecting the reduction in the use of heavy fuel oil and other fossil fuels other than diesel and the increase in the use of renewable energy (see figure 37). It should be noted that the rapid decline in renewable energy consumption in the 2007 – 2014 period reflects the decline in the use of by-products of the sugarcane industry to power sugar production.

Figure 36
Growth in energy consumption of the industrial sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.
[a] The Index of Industrial Production information started in 2004.

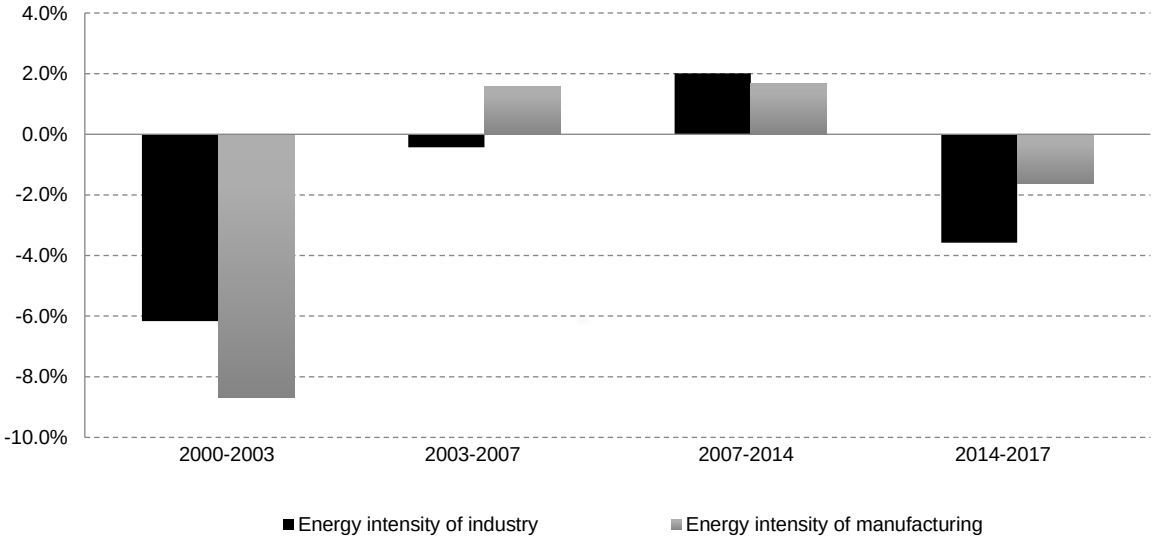
Figure 37
Growth in energy consumption of the industrial sector by type of fuel
(Compounded annual growth rate)



Source: ECLAC and BIEE.

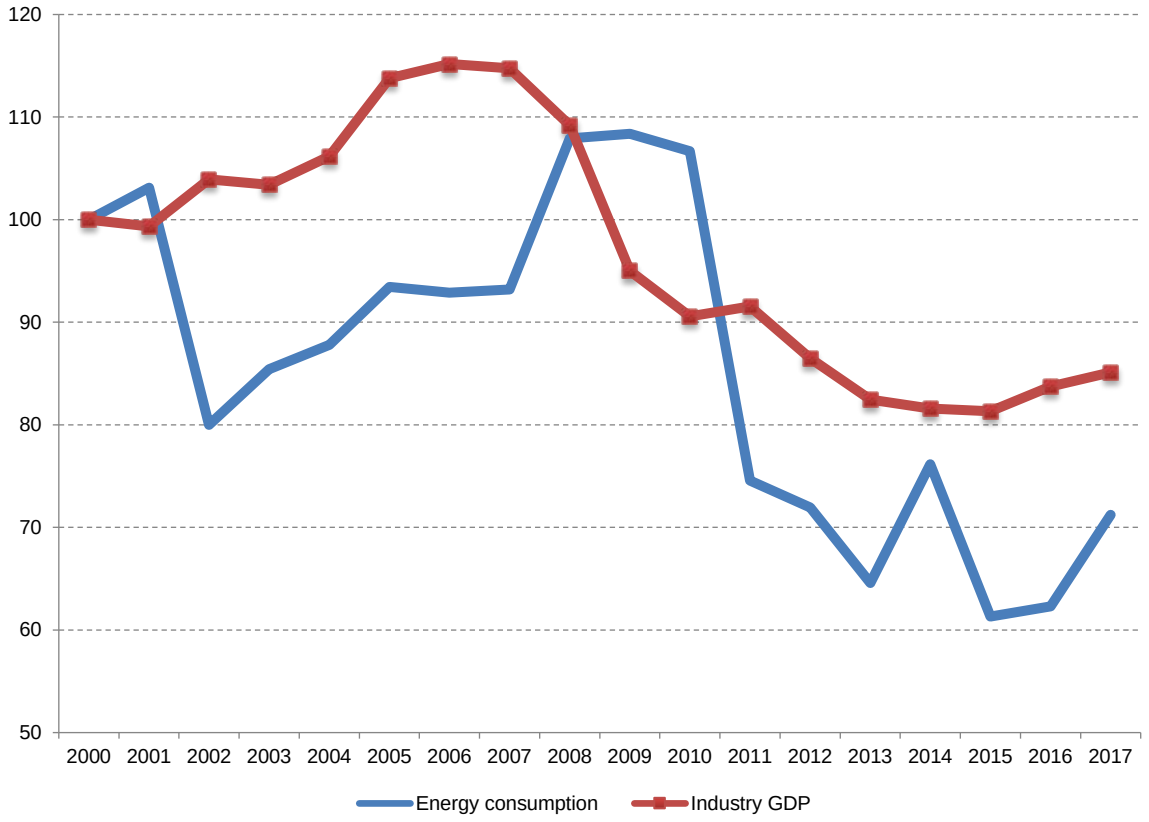
Energy intensity declined by an annual average of 3.6% between 2014 and 2017 (see figure 38), reflecting the faster decline in energy consumption relative to industry GDP (see figure 39). The improvement in energy efficiency was achieved through the switch to more energy efficiency sources, away from ineficiente heavy fuel oil and other fossil fuels (excluding diesel).

Figure 38
Growth in energy intensity of the industrial sector and the manufacturing sub-sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.

Figure 39
Growth in energy consumption and GDP of industry sector
(Index)



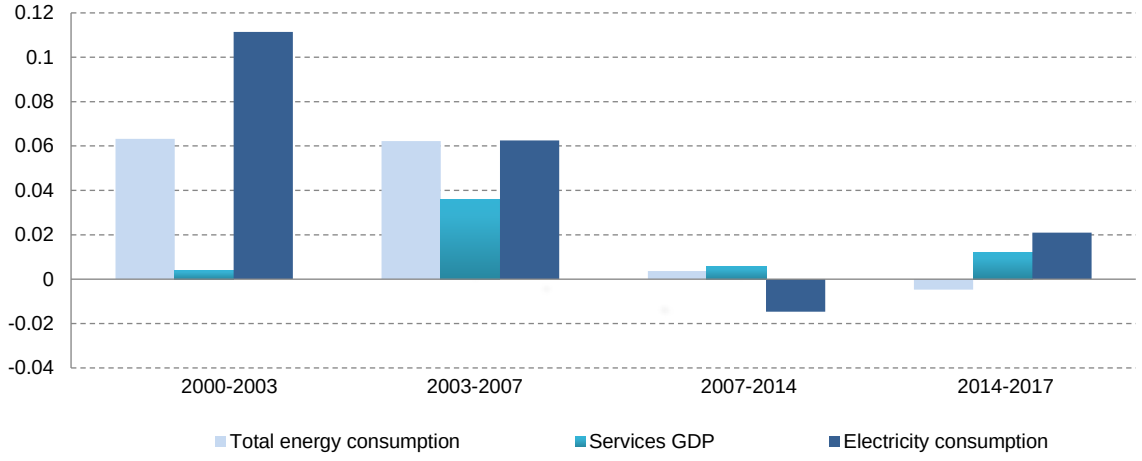
Source: ECLAC and BIEE.

VIII. Energy efficiency trends in services sector

A. Trends in energy consumption of the services sector

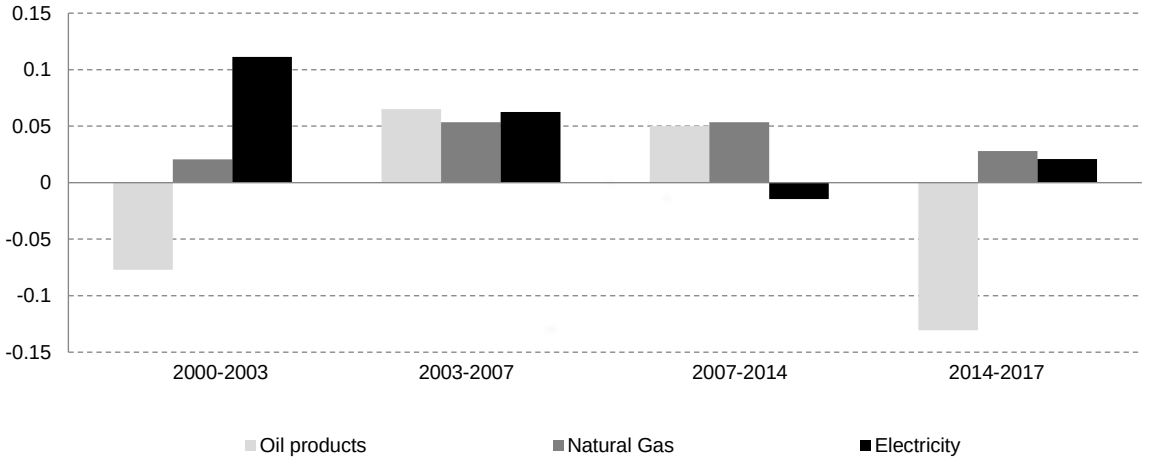
After marginal growth in the 2000 – 2003 period, growth in the services sector increased and drove the economic expansion of the 2003 – 2007 period, before slowing thereafter. Energy consumption patterns have typically mimicked those of services GDP. However, in the 2014 – 2017 period when the pace of growth in services GDP increased, energy consumption declined (see figure 40). The decline in energy consumption was the result of a reduction in the use of oil products (see figure 41).

Figure 40
Growth in energy consumption of the services sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.

Figure 41
Growth in energy consumption of the services sector by fuel type
(Compounded annual growth rate)

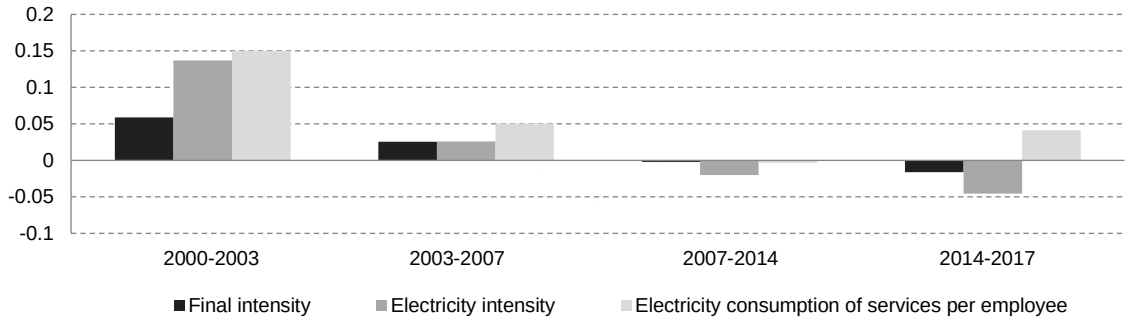


Source: ECLAC and BIEE.

B. Trends in energy efficiency of the services sector

Efficiency in the services sector has been improving, as reflected in the declining growth rates for final intensity and electricity intensity (see figure 42). The improvement in intensity is the result of the shift away from the use of oil products, particularly in the 2014 – 2017 period. Electricity consumption per employee, on the other hand, grew in the 2014 – 2017 period.

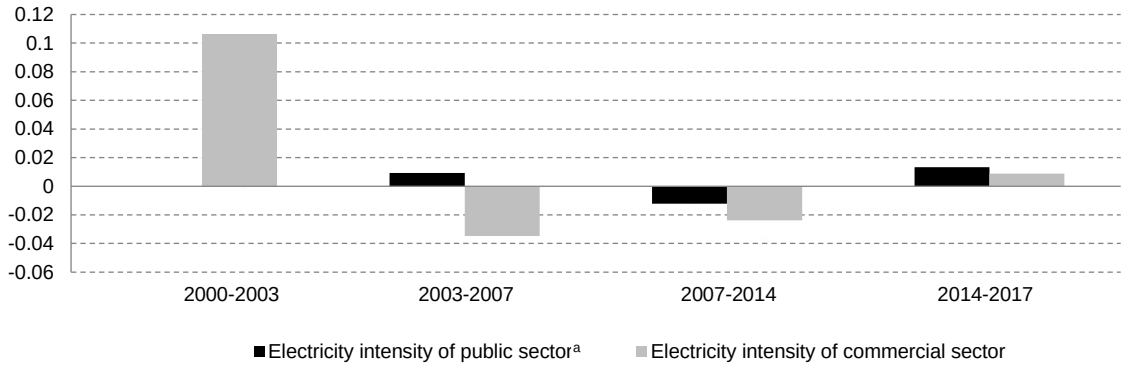
Figure 42
Trends in energy efficiency in the services sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.

Electricity efficiency in the commercial sub-sector has shown the greatest improvement, with electricity intensity declining for more than a decade and increasing only marginally with the 2014 – 2017 period. Electricity efficiency in the public sub-sector also improved in the 2007 – 2014 period, though the rate of improvement was not as pronounced.

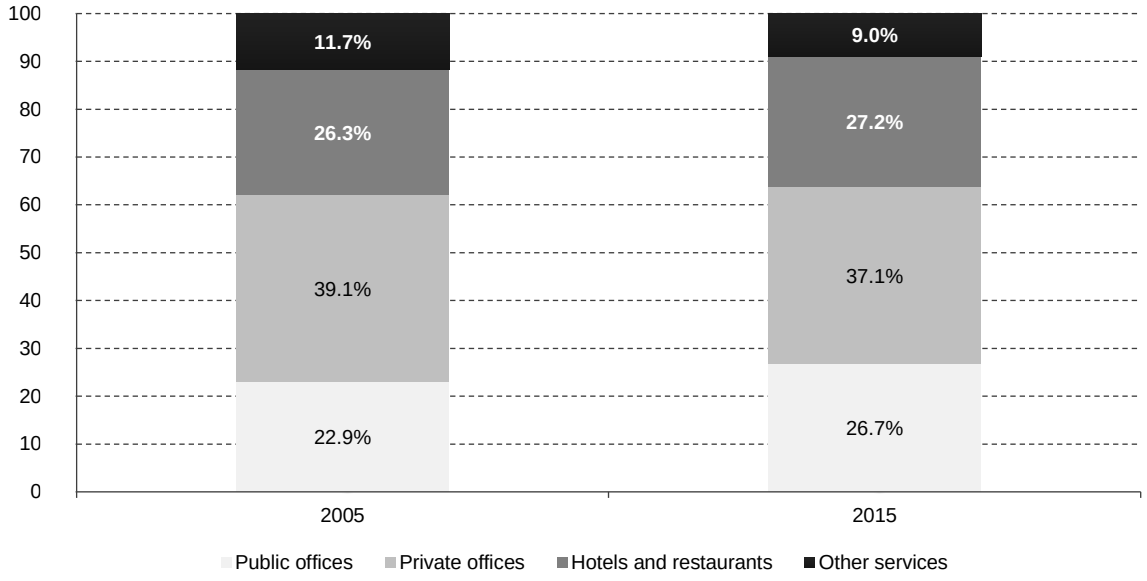
Figure 43
Electricity intensity of the public and commercial sectors
(Compounded annual growth rate)



Source: ECLAC and BIEE.
[a] Electricity consumption of the public sector available from 2005.

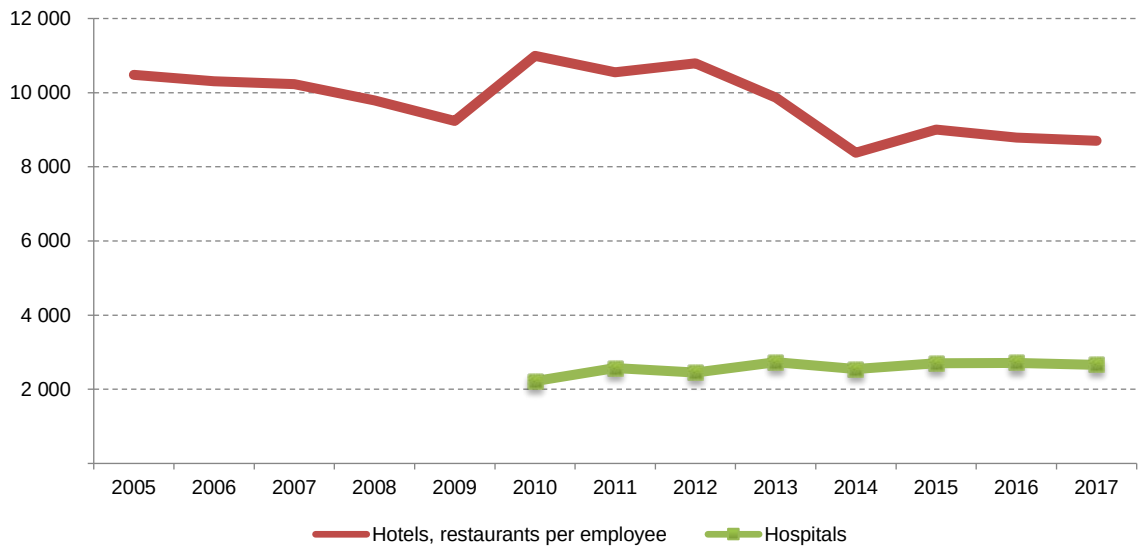
Although the share of public services in energy consumption increased in the ten years to 2015, the commercial sub-sector continued to dominate services. Consumption of energy in the commercial sub-sector can be further disaggregatd into private offices, hotels and restaurants and other services. As shown in figure 44, private offices consumed the lagest share of energy, followed by hotel and restaurants. The trend in electricity consumption for hotels and restaurants per employee declined between 2011 and 2014 and appears to have stabilised since (see figure 45). The tourism sector – of which hotel and restaurants play a critical role – have been accessing fiscal incentives aimed at becoming more energy efficient since 2013.

Figure 44
Share of energy consumption of sub-branches of services sector
(Percentage)



Source: ECLAC and BIEE.

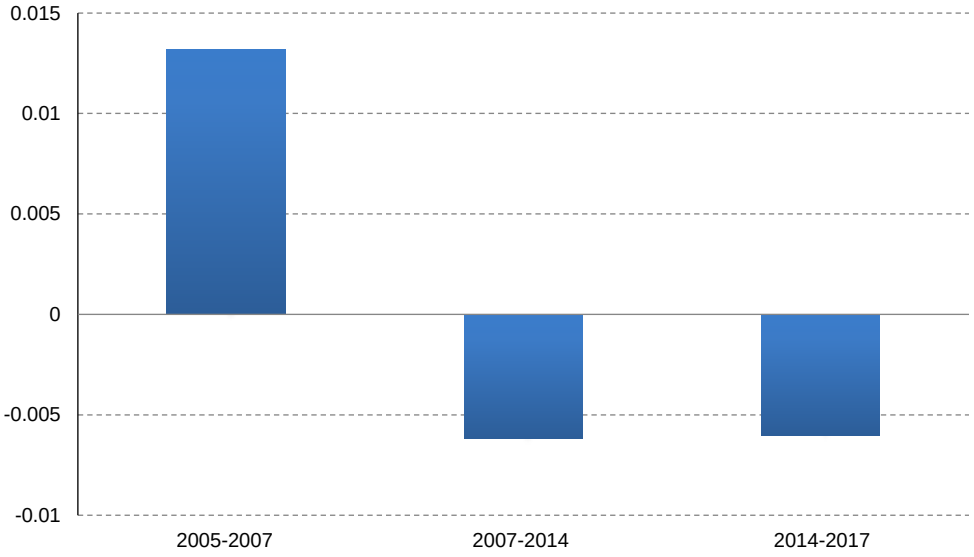
Figure 45
Trends in electricity consumption per employee by key services sub-sectors
(kWh/employee)



Source: ECLAC and BIEE.

Partially reflecting the deterioration in the fiscal accounts, the electricity consumption for public lighting per capita has averaged annual declines since 2007 (see figure 46).

Figure 46
Trends in electricity consumption of public lighting per capita
(Compounded annual growth rate)

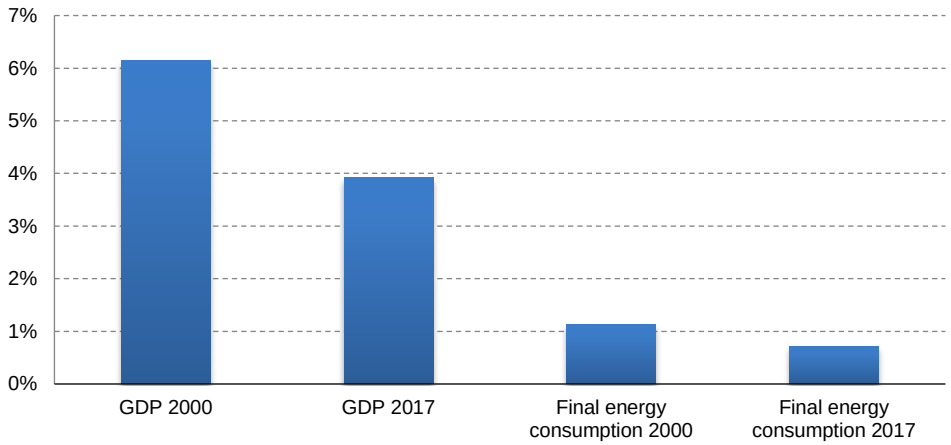


Source: ECLAC and BIEE.

IX. Energy efficiency trends in agriculture sector

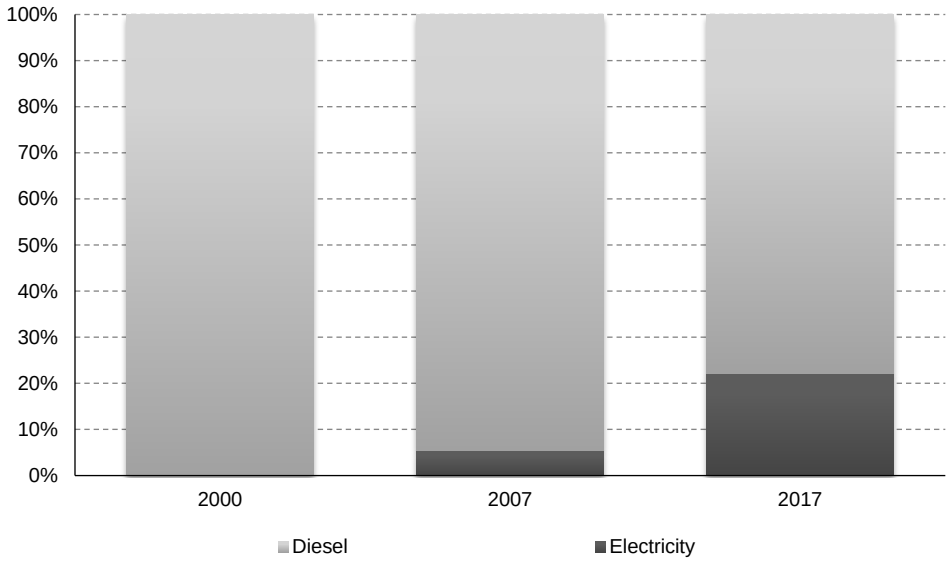
Agriculture's share in GDP and final energy consumption is low and falling: between 2000 and 2017, agriculture's share in GDP dropped from 6.1% to 3.9% and its share in final energy consumption from 1.1% to 0.7% (see figure 47). The fuel mix is dominated by diesel, though electricity consumption has increased notably from 5.5% in 2007 to 22.1% in 2017 (see figure 48). Energy in the agricultural sector is mainly for irrigation, powering fishing vessels and fish harvesting operations, operating machinery and in animal husbandry. Exploratory work has identified the possibility of producing ethanol from a different type of sugar cane than currently produced, as well as biogas from agricultural waste.

Figure 47
Share of agriculture in GDP and final energy consumption
(Percentages)



Source: ECLAC and BIEE.

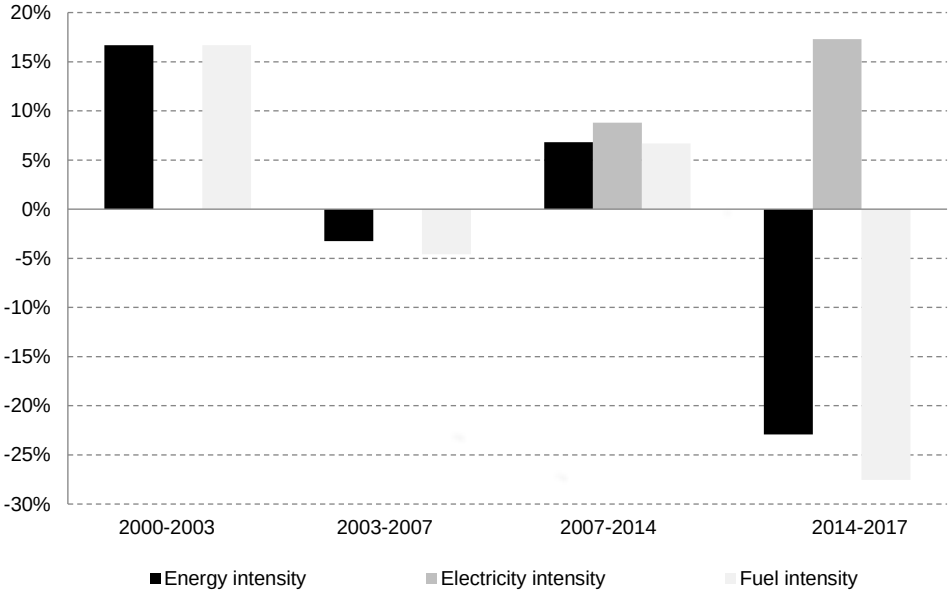
Figure 48
Agriculture fuel mix
(Percentages)



Source: ECLAC and BIEE.

Energy efficiency in the agriculture sector has been improving in the 2014 – 2017 period, as a result of sharp declines in fuel intensity. Electricity intensity, on the other hand, continues to increase rapidly, driven by the growth in electricity consumption of the sector (see figure 49).

Figure 49
Energy intensity of the agriculture sector
(Compounded annual growth rate)



Source: ECLAC and BIEE.

X. Conclusions

Energy efficiency is an under-studied area in Barbados, and this report has been the first attempt at objectively assessing the state of energy efficiency in the country. As expected, therefore, there are areas that can be improved over time. First, the country lacks a national policy that comprehensively addresses energy efficiency. The DoE has drafted an Energy Efficiency Action Plan that, once finalised, will guide the energy efficiency interventions at the national level. The goal of the plan is to ensure that the country takes a wholistic approach to dealing with energy efficiency and conservation.

The second area of improvement relates to data consistency. There are some inconsistencies and inaccuracies in the energy balance statistics that appear to stem from inaccurate data entry. Specifically, some of the data providers seem to be entering their numbers into the wrong fields, which in turn requires manual correction when they are collated. Furthermore, the energy balance at the DoE differs from that of OLADE because OLADE appears to make further adjustments to the energy balance statistics after receiving them from the DoE.

The absence of data to facilitate a deeper analysis of certain sectors is another key challenge. This is most apparent in the transportation sector where, despite the fact that information is collected by the Licensing Authority of the Government of Barbados on the number of vehicles by type of vehicle, required information was not available for the years following 2013. Furthermore, the statistics that were available did not include sales information. As a result, it was not possible to analyse energy efficiency by type of vehicle nor the impact of the changes in the type of vehicle on overall energy efficiency of the transportation sector. To ensure that this will be possible in the future, the following information will need to be collected: sales of new vehicles by type, registration of second hand vehicles by type, average distance travelled per year by type of vehicle, passenger traffic by vehicle, and freight traffic by volume. In addition to updating the vehicle data, fuel consumption statistics should also be collected, and special attention should be paid to incorporating information on electric vehicles. Another sector that would benefit from the incorporation of additional data is the household sector. Although the coverage is much broader than many sectors, the addition of a few fields to the population census would facilitate even deeper analysis. Specifically, collecting information on the number of households with air conditioners and fans, when combined with data on the consumption of various appliances, would permit an analysis of the impact of the changes in the usage of various appliances on energy efficiency. Furthermore, once information is available on the proportion of energy efficient appliances by type, an even deeper assessment would be possible.

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The Energy Division of the Ministry of Energy and Water Resources of Barbados developed a database that allows for analysis of energy efficiency indicators and the impact of policies on trends in these indicators for different sectors of the country. This data will form the baseline of the energy efficiency campaign launched by the Energy Division and evidence-based policy development. In addition, this exercise is expected to strengthen the institutional capacity to collect, collate and analyse energy efficiency data.

This report analyses the information collected for the main sectors of the country, including energy, industry, transportation, agriculture and services, as well as households, and explains the energy efficiency trends in Barbados for the period from 2000 to 2017.

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